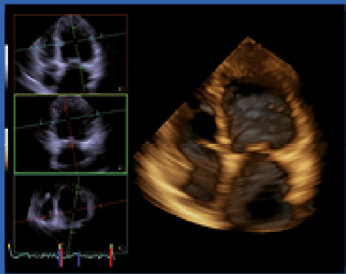


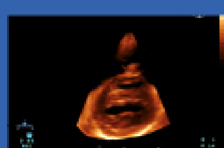
EuroValve

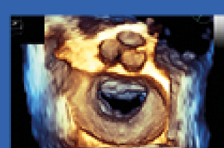
March 27 - 28, 2015

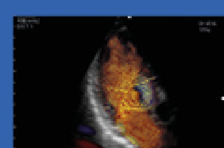
Why is MITRAL REGURGITATION so important in HEART FAILURE ?

And how do we fix it ?

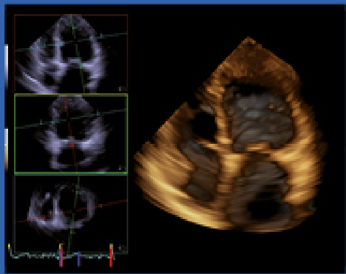
Prof. Dr. R. Dion, ZOL – Genk, Belgium







www.eurovalvecongress.com



EuroValve

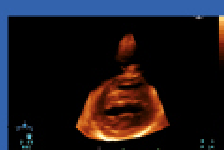
March 27 - 28, 2015

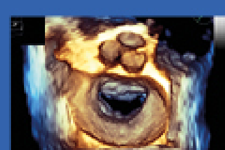
Faculty disclosure

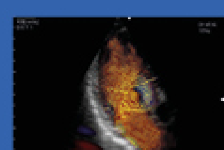
Robert Dion

<u>I disclose the following financial relationships:</u>

Consultant for:
- Sorin Biomedica
- Edwards Lifesciences
- St-Jude Medical
- Johnson & Johnson



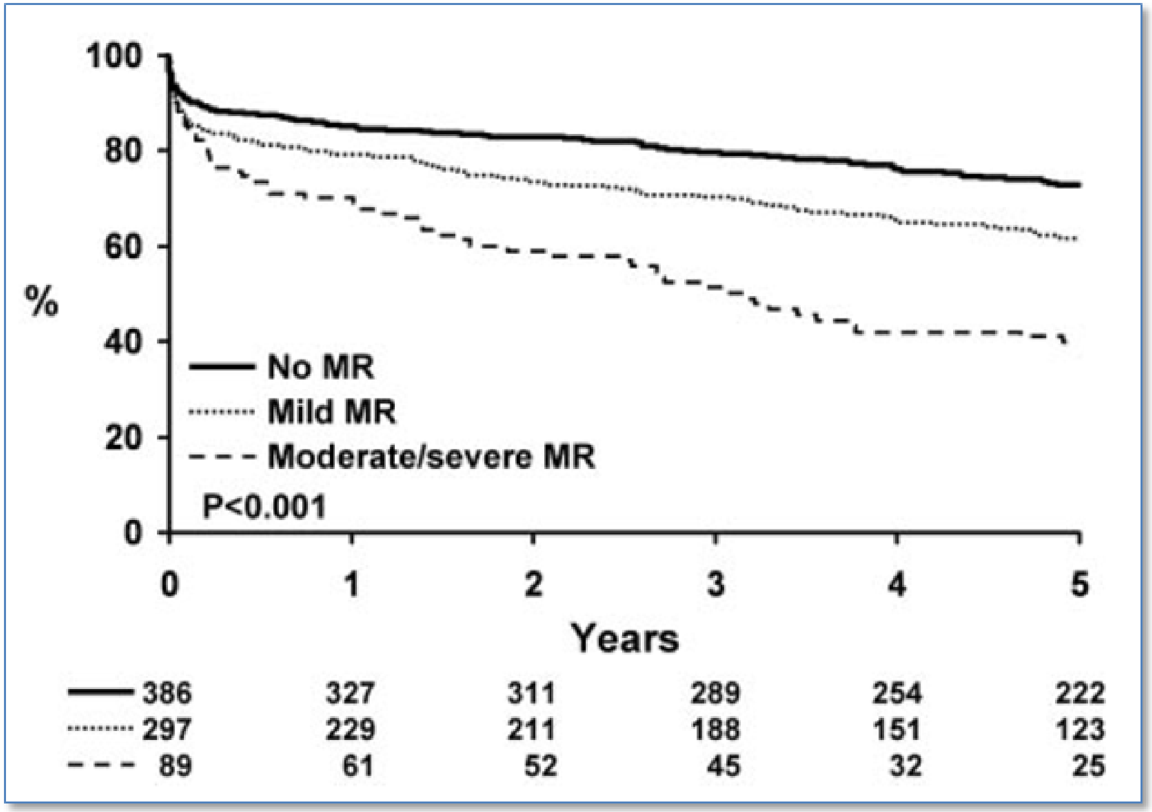




Why is MR so important ?

Background

- Ischemic mitral regurgitation (IMR)



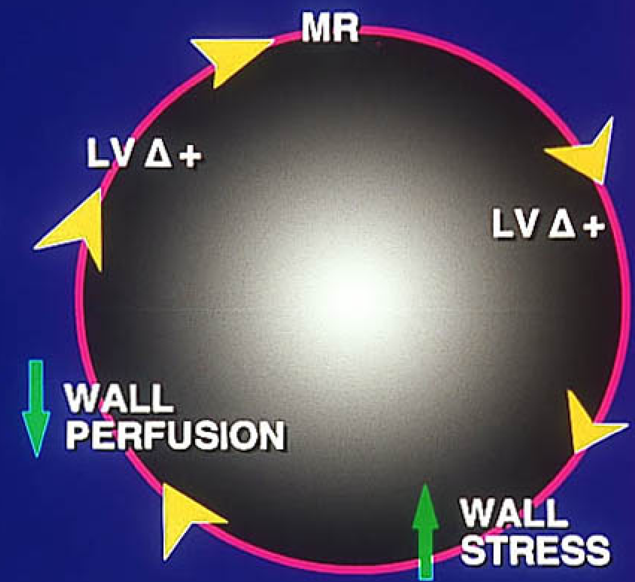
Grigioni et al, Circulation, 2001
Bursi et al, Circulation, 2005

IMR: Regurgitant Volume and 5y Survival

0 ml	→	61%
1 – 19 ml	→	47%
> 30 ml	→	21%

M. Enriquez-Sarano

ISCHEMIC MITRAL REGURGITATION



the vicious circle

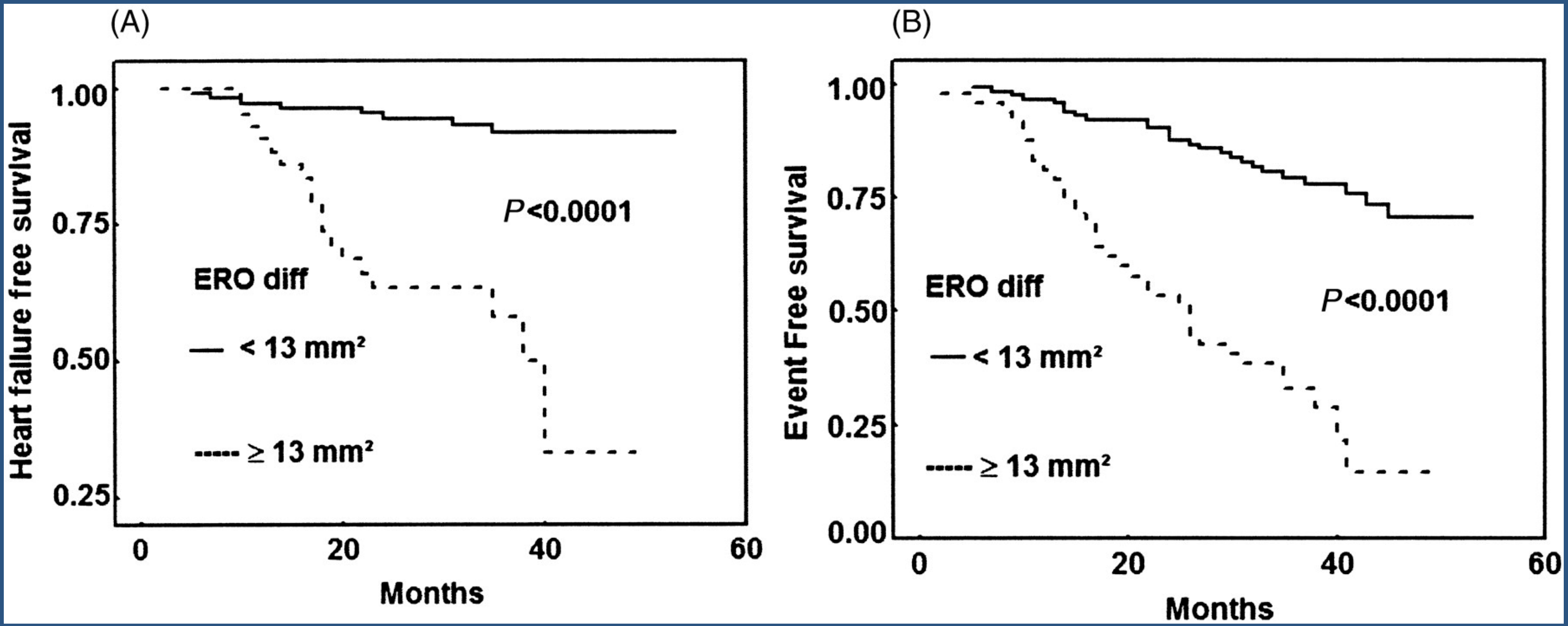
- **Perioperative consequences even if reversible later on**
  (Meyer 1991)

- **Late deaths x 2 if significant residual IMR**
  (Adler 1986, Rankin 1991)

UCL 0193

Importance of exercise induced IMR

- The degree of IMR at baseline was not an independent predictor of morbidity
- ERO diff>13mm^2, LVEFdiff, LVEDV were independent factors of morbidity
- 1/3of the patients with a large ERO diff who died had moderate MR at rest



Lancellotti, P. et al. Long-term outcome of patients with heart failure and dynamic functional mitral regurgitation. Eur Heart J 2005 26:1528-1532

Influence of Mitral Regurgitation Repair on Survival in the Surgical Treatment for Ischemic Heart Failure Trial

Marek A. Deja, MD; Paul A. Grayburn, MD; Benjamin Sun, MD; Vivek Rao, MD; Lilin She, PhD; Michał Krejca, MD; Anil R. Jain, MS; Yeow Leng Chua, MBBS; Richard Daly, MD; Michele Senni, MD; Krzysztof Mokrzycki, MD; Lorenzo Menicanti, MD; Jae K. Oh, MD; Robert Michler, MD; Krzysztof Wróbel, MD; Andre Lamy, MD; Eric J. Velazquez, MD; Kerry L. Lee, PhD; Robert H. Jones, MD

Methods and Results—*Patients with ejection fraction ≤35% and coronary artery disease amenable to CABG were* randomized at 99 sites worldwide to medical therapy with or without CABG. The decision to treat the mitral valve during CABG was left to the surgeon. The primary end point was mortality. Of 1212 randomized patients, 435 (36%) had none/trace MR, 554 (46%) had mild MR, 181 (15%) had moderate MR, and 39 (3%) had severe MR. In the medical arm, 70 deaths (32%) occurred in patients with none/trace MR, 114 (44%) in those with mild MR, and 58 (50%) in those with moderate to severe MR. In patients with moderate to severe MR, there were 29 deaths (53%) among 55 patients randomized to CABG who did not receive mitral surgery (hazard ratio versus medical therapy, 1.20; 95% confidence interval, 0.77–1.87) and 21 deaths (43%) among 49 patients who received mitral surgery (hazard ratio versus medical therapy, 0.62; 95% confidence interval, 0.35–1.08). After adjustment for baseline prognostic variables, the hazard ratio for CABG with mitral surgery versus CABG alone was 0.41 (95% confidence interval, 0.22– 0.77; *P=0.006).*

Conclusion—*Although these observational data suggest that* ***adding mitral valve repair to CABG*** *in patients with left* ventricular dysfunction and moderate to severe MR **may improve survival** compared with CABG alone or medical therapy alone, a prospective randomized trial is necessary to confirm the validity of these observations.

Coronary Artery Bypass Surgery With or Without Mitral Valve Annuloplasty in Moderate Functional Ischemic Mitral Regurgitation

Final Results of the Randomized Ischemic Mitral Evaluation (RIME) Trial

K.M. John Chan, FRCS CTh; Prakash P. Punjabi, FRCS CTh; Marcus Flather, MD, FRCP; Riccardo Wage, DCR (R); Karen Symmonds, DCR (R); Isabelle Roussin, MD; Shelley Rahman-Haley, MD, FRCP; Dudley J. Pennell, MD, FRCP; Philip J. Kilner, MD, PhD; Gilles D. Dreyfus, MD; John R. Pepper, MChir, FRCS; for the RIME Investigators

Background—The role of mitral valve repair (MVR) during coronary artery bypass grafting (CABG) in patients with moderate ischemic mitral regurgitation (MR) is uncertain. We conducted a randomized, controlled trial to determine whether repairing the mitral valve during CABG may improve functional capacity and left ventricular reverse remodeling compared with CABG alone.

Methods and Results—Seventy-three patients referred for CABG with moderate ischemic MR and an ejection fraction > 30% were randomized to receive CABG plus MVR (34 patients) or CABG only (39 patients). The study was stopped early after review of interim data. At 1 year, there was a **greater improvement in the primary end point of peak oxygen consumption** in the CABG plus MVR group compared with the CABG group (3.3 mL/kg/min versus 0.8 mL/kg/min; $P<0.001$). There was also a greater improvement in the secondary end points in the CABG plus MVR group compared with the CABG group: left ventricular end-systolic volume index, MR volume, and plasma **B-type natriuretic peptide reduction** of 22.2 mL/m², 28.2 mL/beat, and 557.4 pg/mL, respectively versus 4.4 mL/m² ($P=0.002$), 9.2 mL/beat ($P=0.001$), and 394.7 pg/mL ($P=0.003$), respectively. Operation duration, blood transfusion, intubation duration, and hospital stay duration were greater in the CABG plus MVR group. Deaths at 30 days and 1 year were similar in both groups: 3% and 9%, respectively in the CABG plus MVR group, versus 3% ($P=1.00$) and 5% ($P=0.66$), respectively in the CABG group.

Conclusions—Adding mitral annuloplasty to CABG in patients with moderate ischemic MR may improve functional capacity, left ventricular reverse remodeling, MR severity, and B-type natriuretic peptide levels, compared with CABG alone. The impact of these benefits on longer term clinical outcomes remains to be defined.

Circulation. 2012;126:2502-2510

Prevention of Ischemic Mitral Regurgitation Does Not Influence the Outcome of Remodeling After Posterolateral Myocardial Infarction

T. Sloane Guy IV, MD,* Sina L. Moainie, MD,* Joseph H. Gorman III, MD,* Benjamin M. Jackson, MD,
Theodore Plappert, CVT,† Yoshiharu Enomoto, MD,* Martin G. St. John-Sutton, MBBS, FACC,†
L. Henry Edmunds, Jr, MD,* Robert C. Gorman, MD*

Philadelphia, Pennsylvania

OBJECTIVES This study was designed to test the hypothesis that ischemic mitral regurgitation (IMR) results from, but does not influence, the progression of left ventricular (LV) remodeling after posterolateral infarction.

CONCLUSIONS Prophylactic ventricular restraint reduces infarct expansion, attenuates adverse remodeling, and reduces IMR severity. Prevention of IMR by prophylactic ring annuloplasty does not influence remodeling. Ischemic mitral regurgitation is a consequence, not a cause, of postinfarction remodeling; infarct expansion is the more important therapeutic target. (J Am Coll Cardiol 2004;43:377–83)

ORIGINAL ARTICLE

Independent prognostic value of functional mitral regurgitation in patients with heart failure. A quantitative analysis of 1256 patients with ischaemic and non-ischaemic dilated cardiomyopathy

Andrea Rossi,[1] Frank L Dini,[2] Pompilio Faggiano,[3] Eustachio Agricola,[4] Mariantonietta Cicoira,[1] Silvia Frattini,[3] Anca Simioniuc,[2] Mariangela Gullace,[4] Stefano Ghio,[5] Maurice Enriquez-Sarano,[6] Pier Luigi Temporelli[7]

DISCUSSION

The main finding of this study is that severe FMR, defined as RV >30 ml or ERO >0.2 cm2 or VC >0.4 cm, is associated with a twofold increased risk of adverse events after adjustment for LVEF and RMP in patients with HF due to DCM. Accordingly, **FMR should not be considered just a mere consequence** of ventricular remodelling but a major predictor for the outcome of patients with HF, suggesting that in patients with severe FMR all therapeutic options of pharmacological and non-pharmacological treatment should be considered. …

… Finally, the demonstration of a clear and powerful association between FMR and prognosis might only suggest that treatment of **FMR may improve outcome**. However, particularly for the percutaneous approach to FMR, the effectiveness of these procedures can be demonstrated only by randomised trials. …

MRI Assessment of Reverse Left Ventricular Remodeling Late After Restrictive Mitral Annuloplasty in Dilated Cardiomyopathy

J Braun, JJM Westenberg, NR van de Veire, RJM Klautz,
MIM Versteegh, SD Roes, RJ van der Geest, A de Roos,
EE van der Wall, JHC Reiber, JJ Bax, RAE Dion

Departments of Cardio-Thoracic Surgery, Radiology and Cardiology
Leids Universitair Medisch Centrum, Leiden, The Netherlands

J Thorac Cardiovasc Surg. 2008 Jun; 135 (6): 1247-52; discussion 1252-3

Patient characteristics

22 selected patients (MRI)

Mild-moderate heart failure	**NYHA 2.2 ± 0.4**
Severe MR	**mean grade 3.6 ± 0.5**
Non-ischemic dilated cardiomyopathy	**LVEF 37 ± 5**
	LVEDV 215 ± 34 ml

Imaging outcome

	pre-surgery	follow-up	*p*
MR grade	3.6 ± 0.5	0.6 ± 0.5	<0.01
Coaptation (mm)	3 ± 1	8 ± 3	<0.01
LAESV/BSA (ml/m^2)	84 ± 20	68 ± 12	<0.01
LAEDV/BSA (ml/m^2)	48 ± 16	44 ± 10	0.15
LVESV/BSA (ml/m^2)	42 ± 14	31 ± 12	<0.01
LVEDV/BSA (ml/m^2)	110 ± 18	80 ± 17	<0.01
LV Mass/BSA (g/m2)	76 ± 21	66 ± 12	0.03
LVEF (%)	37 ± 5	55 ± 10	<0.01

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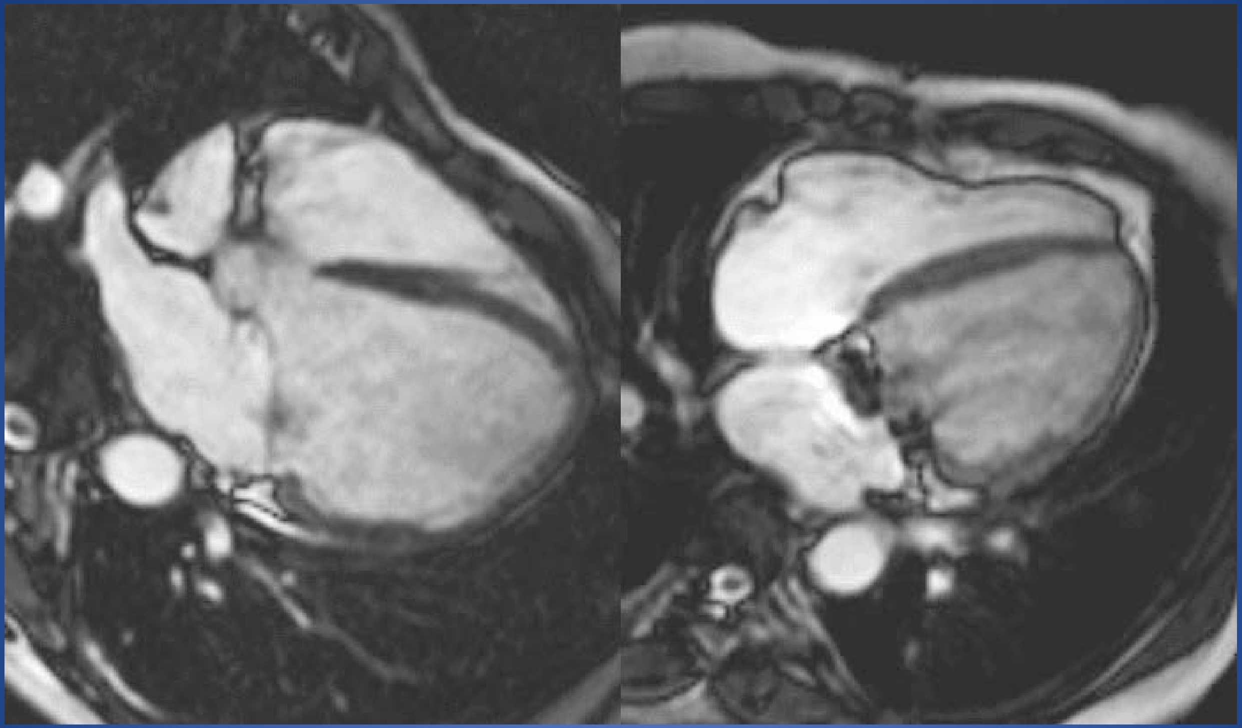
LV Mass/BSA (g/m2)	76 ± 21	66 ± 12	0.03
LVEF (%)	37 ± 5	55 ± 10	<0.01

Conclusion

MRI confirms that in early stages non-ischemic DCM, stringent RMA alone resolves functional MR and induces reverse remodeling in the long term

Long-Term Durability after restrictive MVP



PRE

POST

(note: MI jet)

(note: restrictive ring)

Surgical Treatment of Moderate Ischemic Mitral Regurgitation

P.K. Smith et al N Engl J Med 2014;371:2178-88

Methods

We randomly assigned 301 patients with moderate ischemic mitral regurgitation to CABG alone or CABG plus mitral-valve repair (combined procedure). The primary end point was the left ventricular end-systolic volume index (LVESVI), a measure of left ventricular remodeling, at 1 year. This end point was assessed with the use of a Wilcoxon rank-sum test in which deaths were categorized as the lowest LVESVI rank.

Results

…

There were no significant between-group differences in major adverse cardiac or cerebrovascular events, deaths, readmissions, functional status, or quality of life at 1 year.

Conclusions

In patients with moderate ischemic mitral regurgitation, the addition of mitral-valve repair to CABG did not result in a higher degree of left ventricular reverse remodeling. Mitral-valve repair was associated with a reduced prevalence of moderate or severe mitral regurgitation but an increased number of untoward events. Thus, at 1 year, this trial did not show a clinically meaningful advantage of adding mitral-valve repair to CABG. Longer-term follow-up may determine whether the lower prevalence of mitral regurgitation translates into a net clinical benefit.

Randomized studies RMA vs ≠ RMA in MODERATE IMR

	RIME	SMITH
LVESI preop	78.4	57
Δ⁻ LVESI RMA	28%	9.4%
≠ RMA	6%	9.3%
Persistent MR ≠ RMA	50%	31%
NYHA at 1y RMA vs ≠ RMA	I 76% vs 21% II 20% vs 64% III 4% vs 15%	~

⇨ NOT THE SAME PATIENTS !!!

How do we fix it ?

Before considering surgery in IMR

1) Optimal medical treatment

2) CAVE acute coronary syndrome

? PCI

3) CRT ?

Predictors of Improvement of Unrepaired Moderate Ischemic Mitral Regurgitation in Patients Undergoing Elective Isolated Coronary Artery Bypass Graft Surgery

Martin Penicka, MD, PhD; Hana Linkova, MD; Otto Lang, MD, PhD; Richard Fojt, MD; Viktor Kocka, MD; Marc Vanderheyden, MD; Jozef Bartunek, MD, PhD

Background—The persistence of moderate ischemic mitral regurgitation (IMR) after isolated coronary artery bypass graft surgery is an important independent predictor of long-term mortality. The aim of the present study was to identify predictors of postoperative improvement in moderate IMR in patients with ischemic heart disease undergoing elective isolated coronary artery bypass graft surgery.

Methods and Results—The study population consisted of 135 patients with ischemic heart disease (age, 65±9 years; 81% male) and moderate IMR undergoing isolated coronary artery bypass graft surgery. Fourteen patients died before the 12-month follow-up echocardiography and were excluded. At the 12-month follow-up, 57 patients showed no or mild IMR (improvement group), whereas 64 patients failed to improve (failure group). Before coronary artery bypass graft surgery, the improvement group had significantly more viable myocardium and less dyssynchrony between papillary muscles than the failure group ($P<0.001$). All other preoperative parameters were similar in both groups. Large extent (≥5 segments) of viable myocardium (odds ratio, 1.45; 95% confidence interval, 1.22 to 1.89; $P<0.001$) and absence (<60 ms) of dyssynchrony (odds ratio, 1.49; 95% confidence interval, 1.29 to 1.72; $P<0.001$) were independently associated with improvement in IMR. The majority (93%) of patients with viable myocardium and an absence of dyssynchrony showed an improvement in IMR. In contrast, only 34% and 18% of patients with dyssynchrony and nonviable myocardium, respectively, showed an improvement in IMR, whereas 32% and 49%, respectively, of these patients showed worsening of IMR ($P<0.001$).

Conclusion—Reliable improvement in moderate IMR by isolated coronary artery bypass graft surgery was observed only in patients with concomitant presence of viable myocardium and absence of dyssynchrony between papillary muscles. (*Circulation*. **2009;120:1474-1481.**)

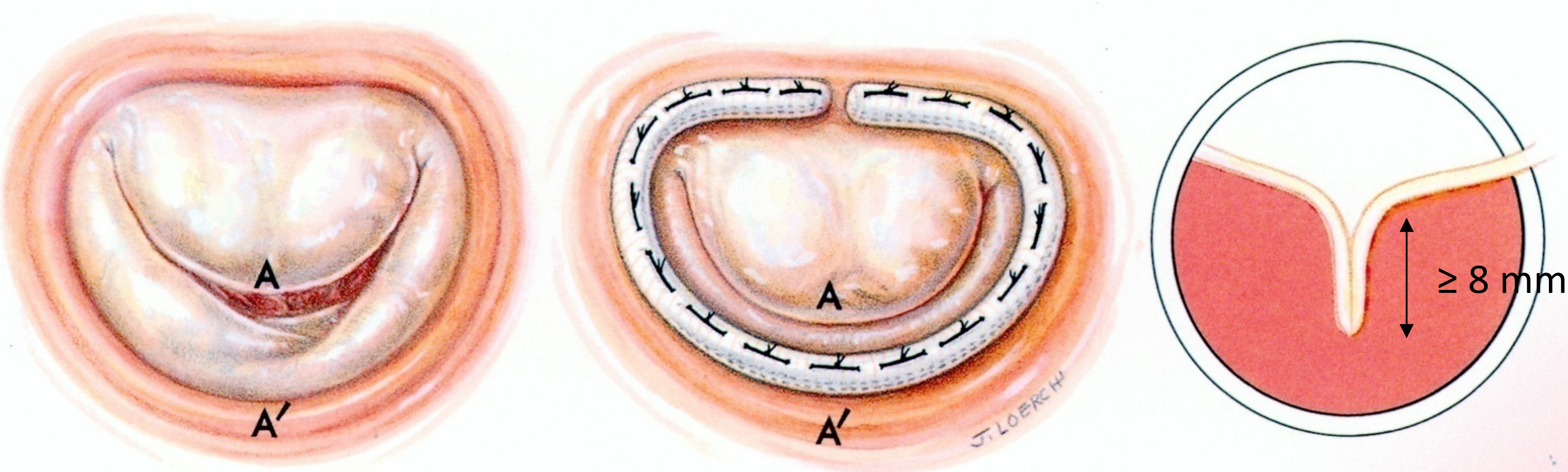
Restrictive Mitral Annuloplasty

=

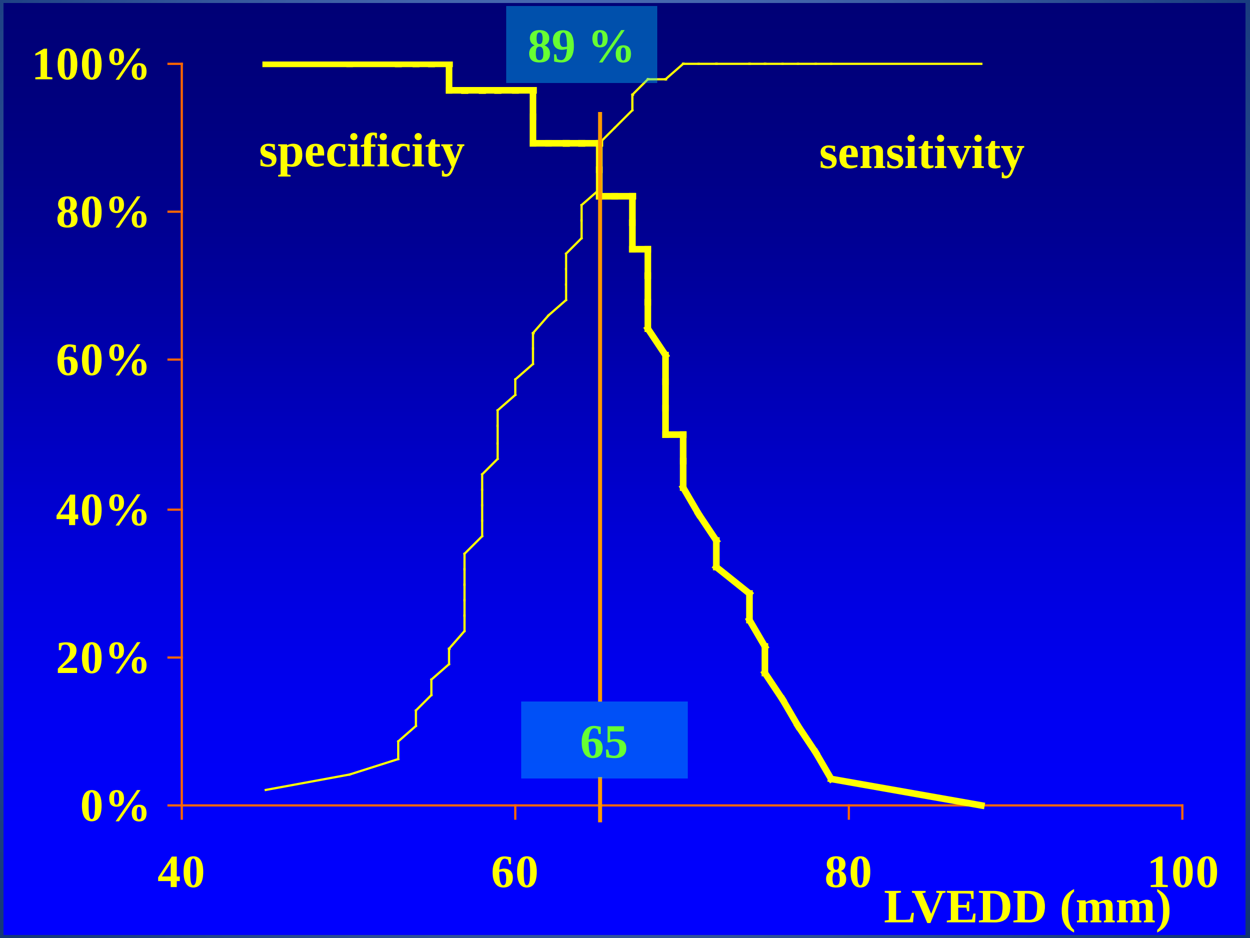
Complete (1/2) rigid ring

+

≥ 8mm coaptation length

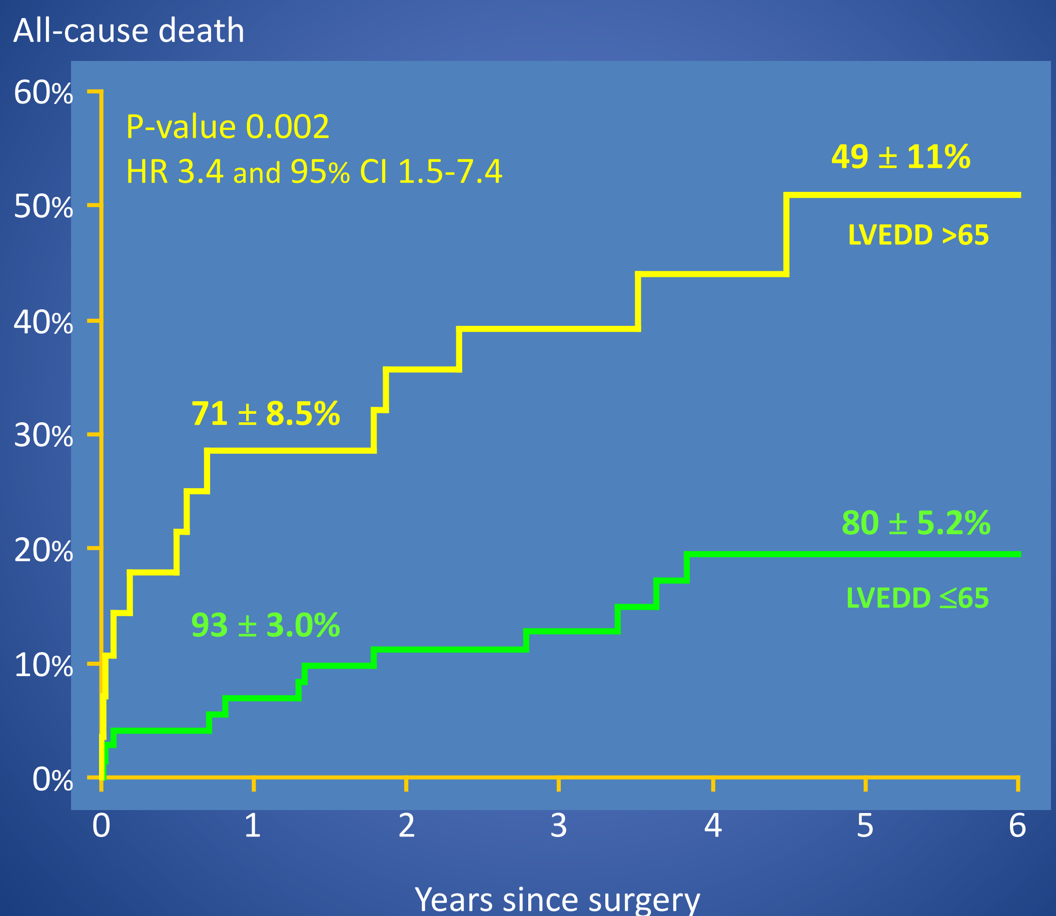

A
A′
A
A′
J. LOERCH
≥ 8 mm

LVEDD and Reverse Remodeling



Bax J et al. Circulation 2004; 110 (suppl II): II-103-II-108

Results: Mortality per LVEDD



Patients at risk	100	87	82	60	40	27	11

Braun J et al. Ann Thorac Surg 2008 Feb;85(2):430-6

Echo Results: Mitral Regurgitation

BASELINE	3.1 ± 0.5
EARLY	0.5 ± 0.7
INTERMEDIATE (18m)	0.7 ± 0.7
LATE (46m)	0.9 ± 0.8

P < 0.05

Braun J et al. Ann Thorac Surg 2008 Feb;85(2):430-6

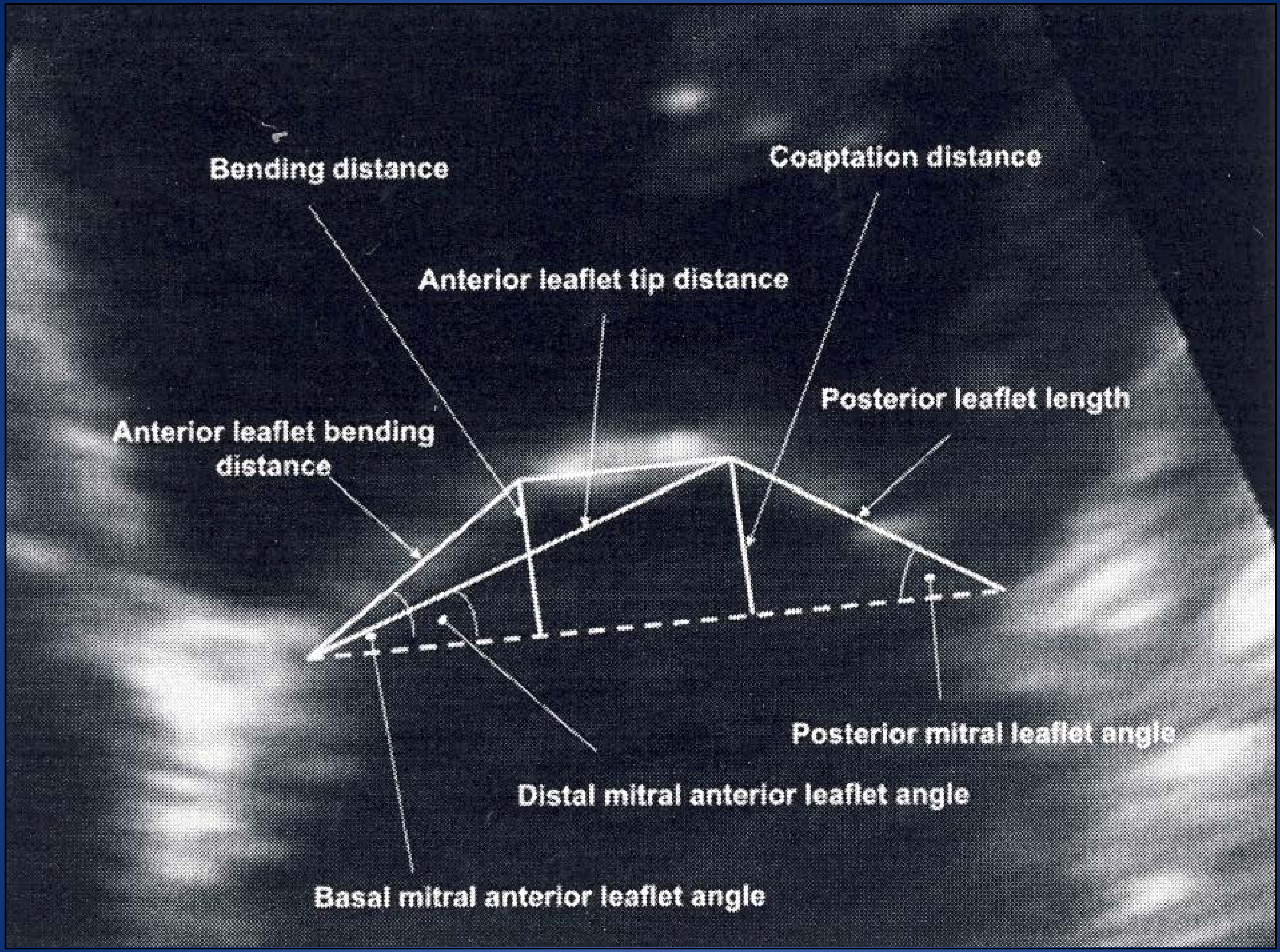
Results: Echocardiography

	baseline	intermediate	late
MV gradient		**3.6 ± 1.5**	**3.9 ± 1.7**
MV area (cm2)		**2.8 ± 0.6**	**2.6 ± 0.6**
Tenting area (cm2)	**4.8 ± 1.4**		**1.4 ± 0.6**
Coaptation Height (mm)	**3 ± 1**	**8 ± 2**	**8 ± 2**

	Cut-off value	AUC	Sensitivity (%)	Specificity(%)
ALA_{base} (°)	34	0.84	80	70
ALA_{tip} (°)	15	0.97	86	91
PLA (°)	45	0.86	86	70
Tenting area (cm^2)	2.5	0.82	75	89
Tenting height (mm)	11	0.79	71	89

Predictors of mitral regurgitation recurrence in patients with heart failure undergoing mitral valve annuloplasty. Agnieszka Ciarka et al

Am J Cardiol 2010;106:395-401

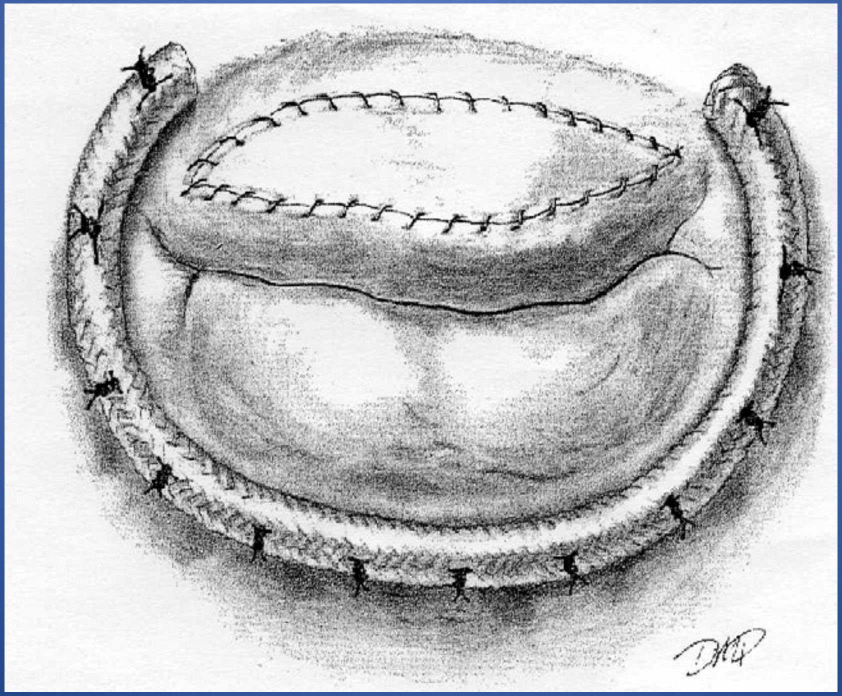


Method of quantification of ALA_{base}, ALA_{tip} and PLA. Measurements depicted on echocardiographic image of mitral valve in apical 4-chamber view in mid-systole.

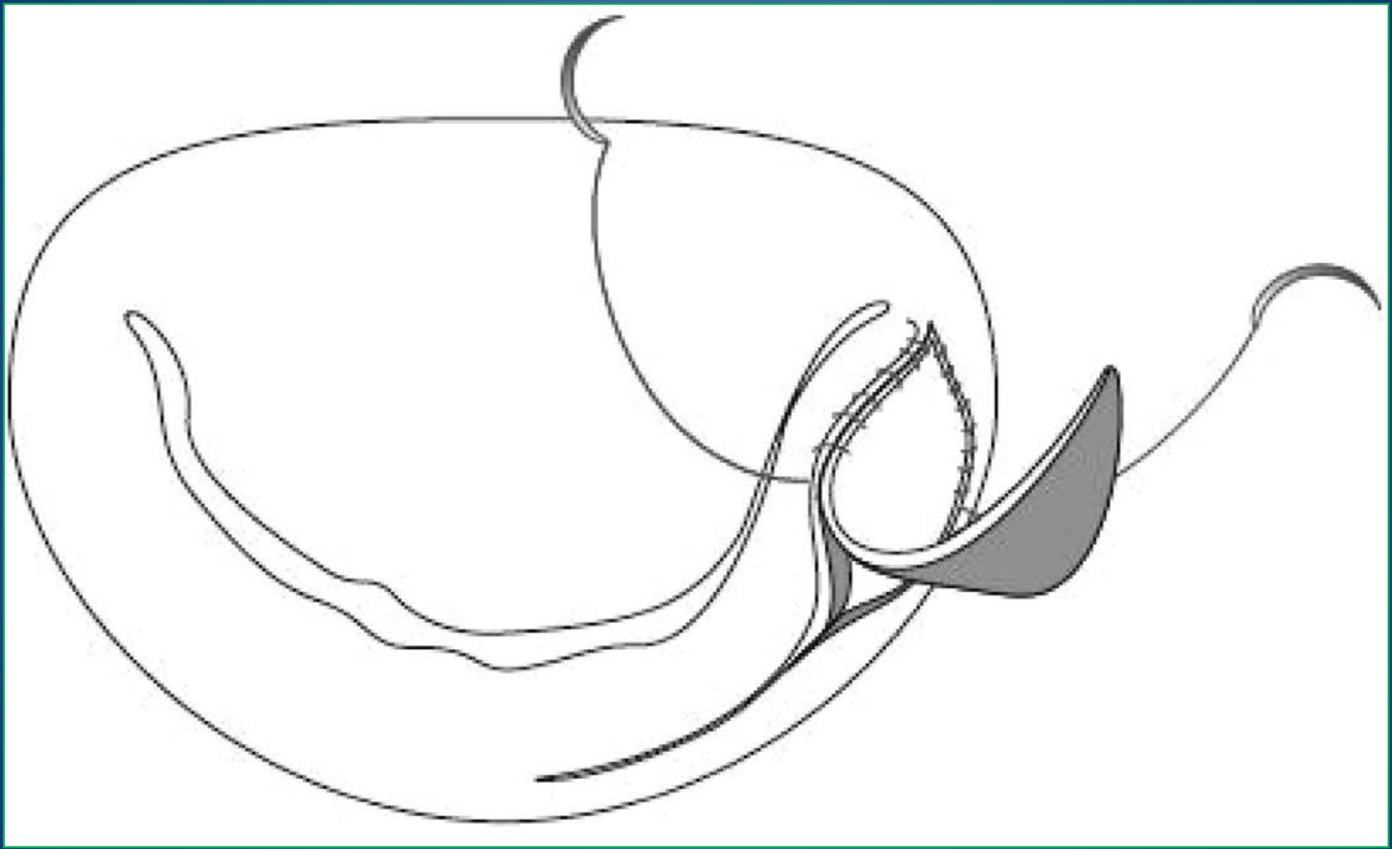
Am J Cardiol 2010;106:395-401. Ciarka et al

Anterior leaflet augumentation for IMR

Kincaid EH, Riley RD, Hines MH, Hammon JW, Kon ND. Anterior leaflet augumentation for ischemic mitral regurgitation. Ann Thora Surg 2004;78:564-8



The bovine pericardial patch extending the medial half of P2 and all of P3

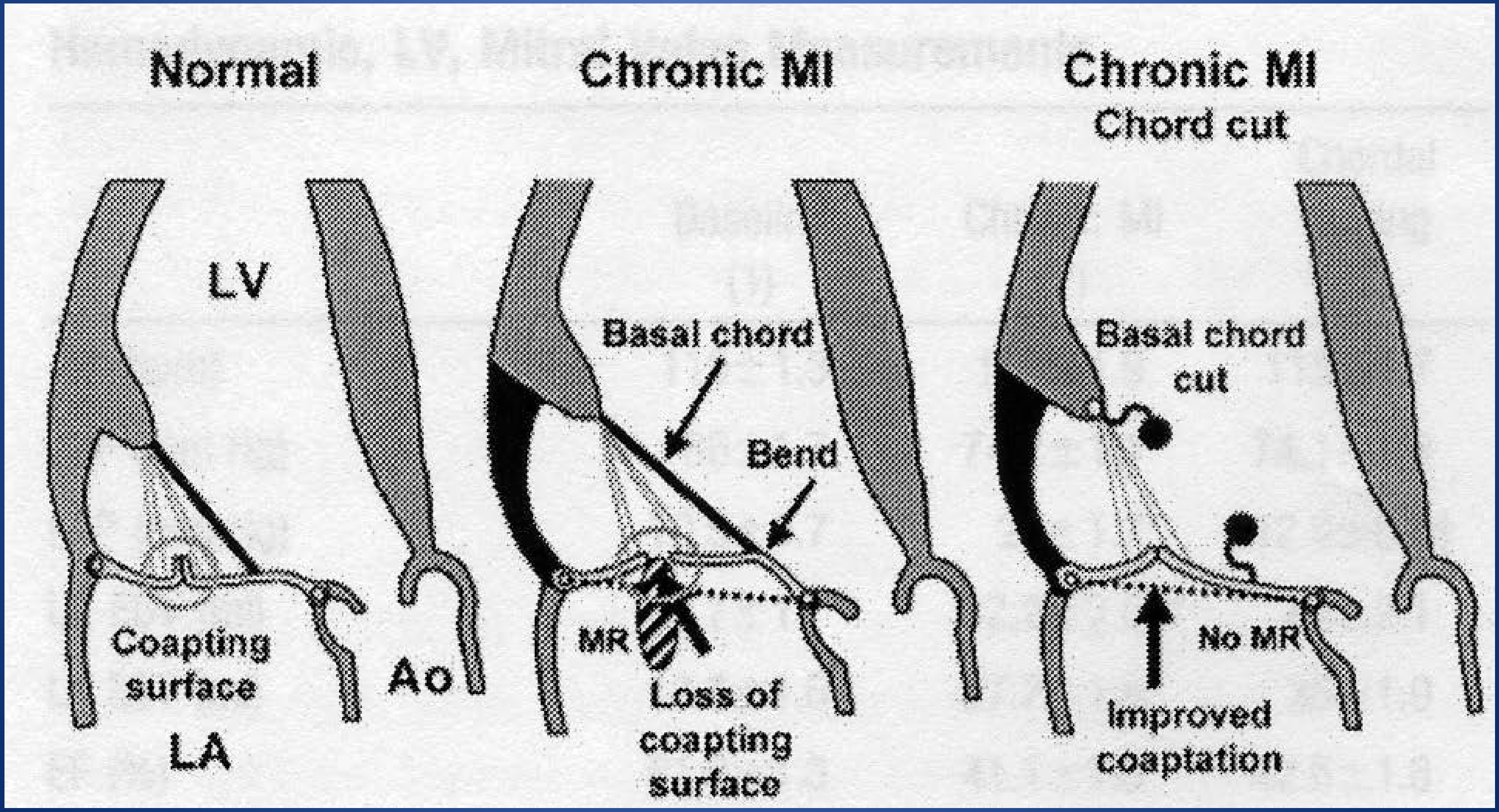


de Varennes, B. et al. Circulation 2009;119:2837-2843

Initial results of posterior leaflet extension for severe type IIIb ischemic mitral regurgitation.

Chordal cutting

Messas E, Pouzet B, Touchot B, et al. Efficacy of chordal cutting to relieve chronic persistent ischemic mitral regurgitation. Circulation 2003;108[suppl II]:II-111-II-115



RING plus STRING: Papillary muscle repositioning as an adjunctive repair technique for ischemic mitral regurgitation

Langer F. JTCS 2007;133:247-9

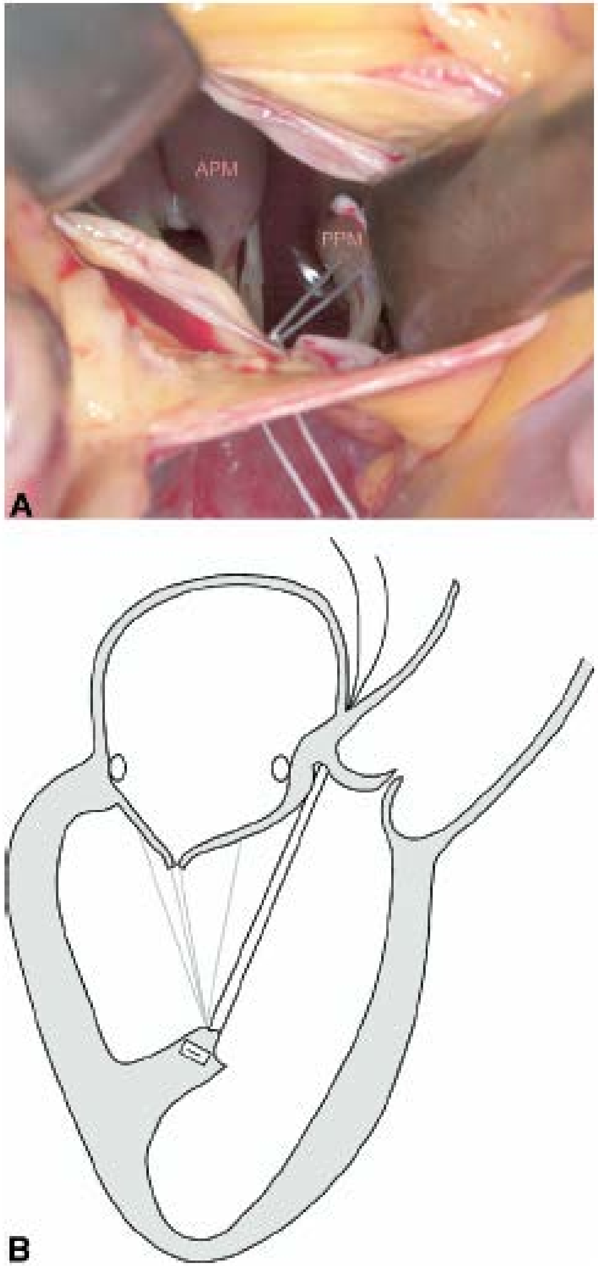
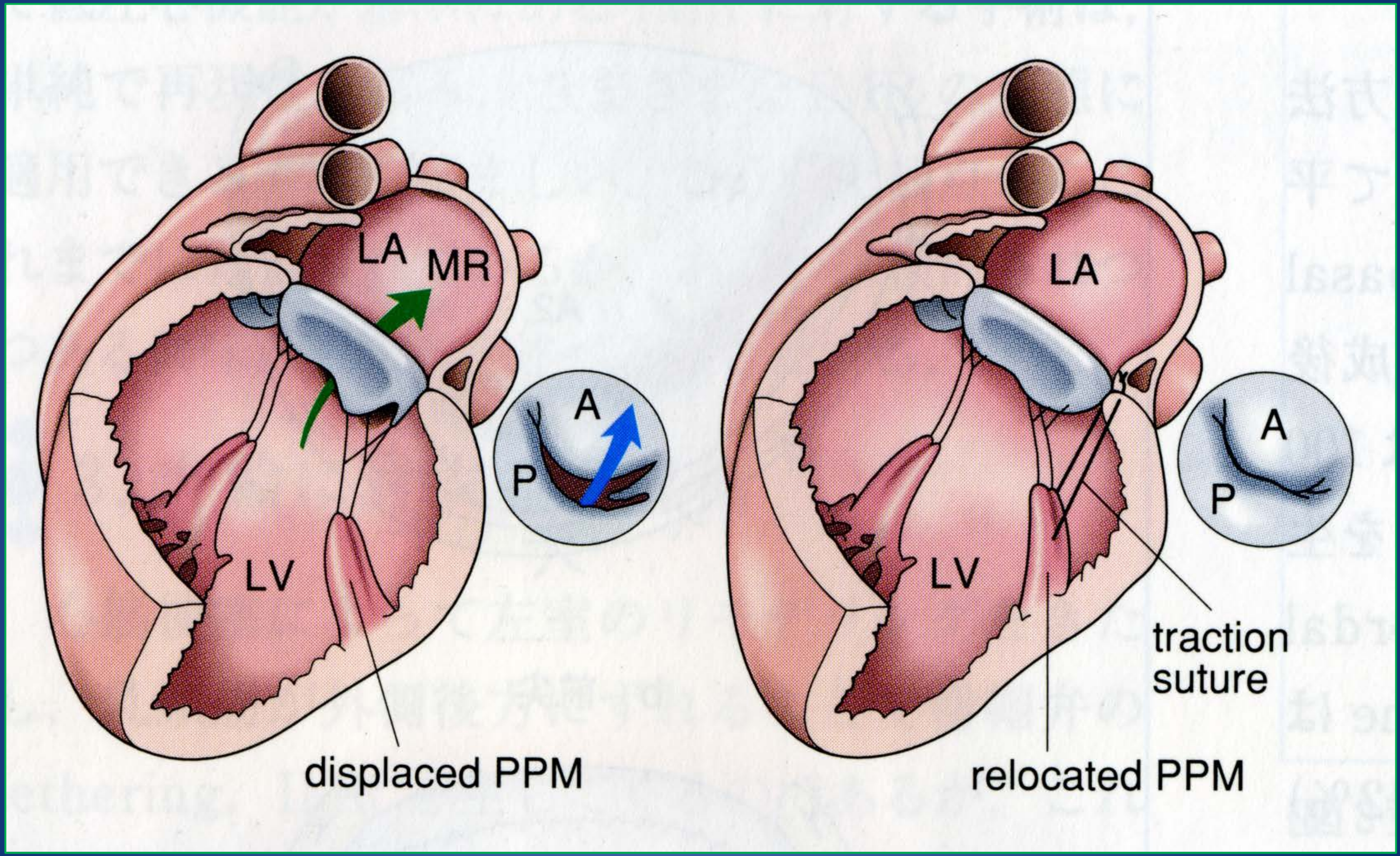


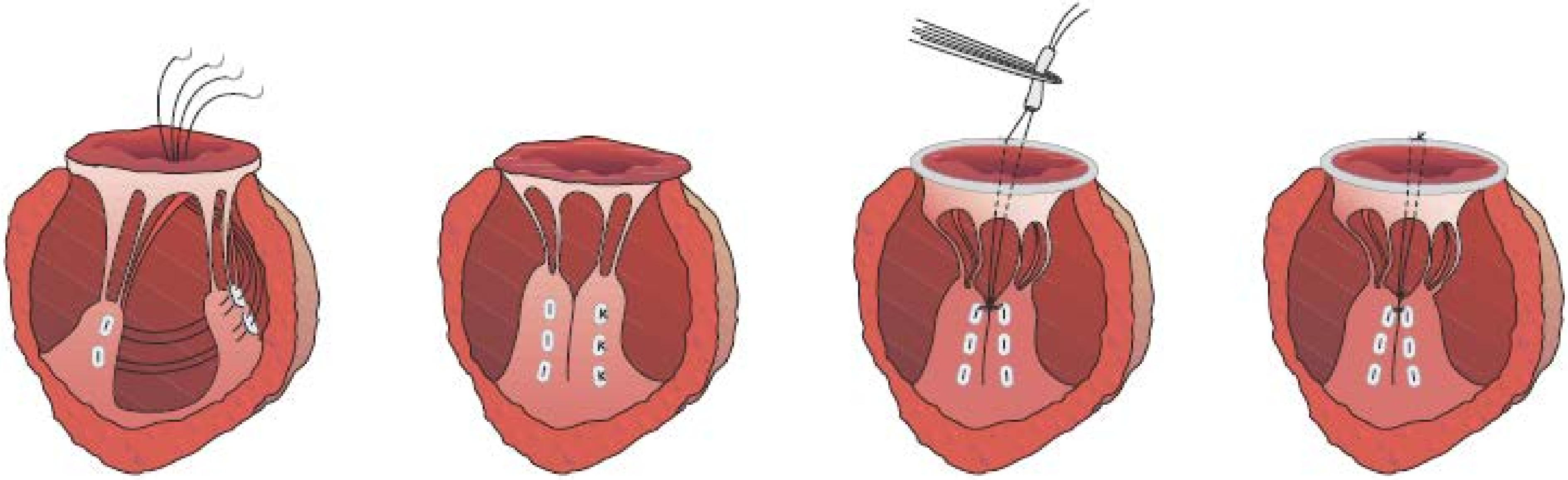
Figure 1. A, Intraoperative photograph of the transventricular suture technique (STRING). A horizontal aortotomy allows excellent exposure of the subvalvular mitral apparatus. A Teflon-pledgeted 4-0 polytetrafluroethylene suture is anchored in the head of the posterior papillary muscle *(PPM)*. The suture is then passed through the fibrosa (midseptal annular saddle horn) under direct vision and exteriorized through the aortic wall underneath the commissure between the noncoronary and left coronary aortic cusps. *APM*, Anterior papillary muscle. B, Schematic representation of the transventricular suture technique (STRING). The suture is tied under echocardiographic guidance in the loaded beating heart to reposition the displaced posterior papillary muscle toward the fibrosa.

Relocation of the posterior papillary muscle (Kron)



Kron IL: Surgical relocation of the posterior papillary muscle in chronic ischemic mitral regurgitation. Ann Thorac Surg 2002;74:600-1

Papillary muscles approximation + papillary muscles suspension



Papillary muscles approximation

CV4 for pulling up both PM

Hvass et al. J Thorac Cardiovasc Surg 2010 Feb; 139(2): 418-23
Shingu Y et al. Circ J. 2009 Nov;73(11):2061-7
Langer F et al. *J Thorac Cardiovasc Surg* 2011 May; 141(5): 1315-6

The Role of Papillary Muscle Relocation in Ischemic Mitral Valve Regurgitation

Khalil Fattouch, MD, PhD,[*] Giacomo Murana, MD,[†]
Sebastiano Castrovinci, MD,[†] Giuseppe Nasso, MD,[‡] and Giuseppe Speziale, MD[‡]

Aim of our study was to compare the results of combined approach papillary muscles relocation **(PPMr) + mitral annuloplasty (MA) vs only restrictive annuloplasty (RA)** in ischemic mitral regurgitation, guided by 3-dimensional (3D) echocardiography. Sixty-nine patients with severe ischemic mitral regurgitation who had PPMr + MA and coronary artery bypass grafting were matched 1:1 with patients who underwent isolated RA and coronary artery bypass grafting. A comprehensive pre- and postoperatory 2-dimensional and 3D transesophageal echocardiographic examination followed by a 3D offline assessment of the mitral valve apparatus was performed. **Five-year freedom from cardiac-related event** in the PPMr + MA group and isolated RA group was **83%** ± 2.1% and **65.4%** ± 1.2%, respectively ($P < 0.001$). **Recurrent mitral regurgitation** equal to or greater than moderate occurred in 2 (**2.8%**) and 8 (**11.5%**) in PPMr + MA group and RA group, respectively ($P < 0.02$). The PPMr promoted a **significant reversal in left ventricle** remodeling compared with the isolated RA. PPMr + MA **reduce the tenting area and the coaptation depth** with respect to RA, with less incidence of recurrent mitral regurgitation.

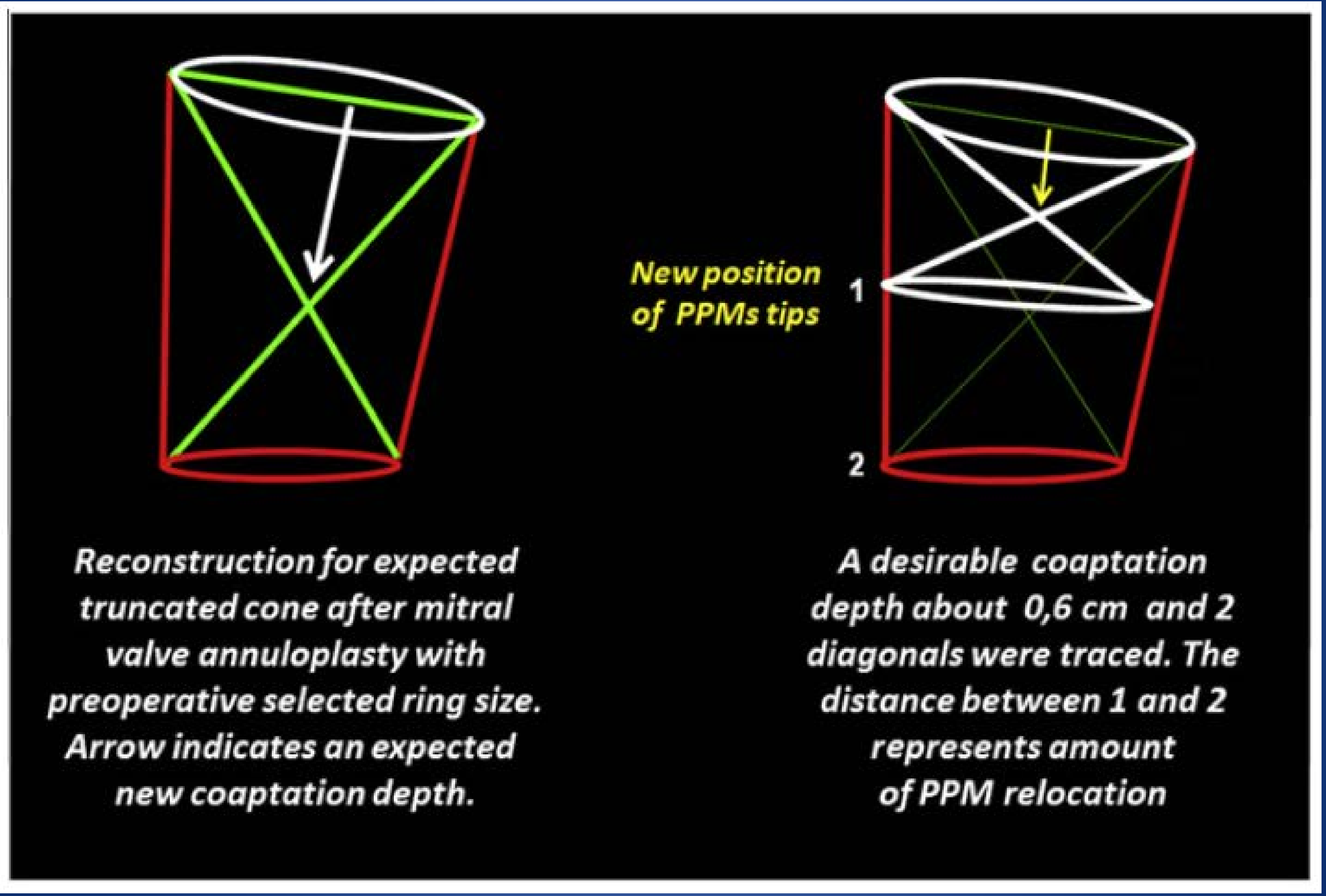
Semin Thoracic Surg 2012; 24:246-253

	Baseline and preop data	Follow-up data		
		PPMR + MA	RA	P
NYHA Class > II	22 (31.9%)	3 (4.3%)	4 (5.8%)	0.81
LVEDD (mm)	57 ± 8	51 ± 7	55 ± 8	0.02
LVESD (mm)	49 ± 1	41 ± 6	45 ± 5	0.02
Mean LVEF %	43 ± 8	46 ± 5	45 ± 9	0.21
Mean tenting area (cm^2)	3.5 ± 0.9	1.2 ± 0.3	2.3 ± 0.4	<0.001
Mean coaptation depth	1.2 ± 0.1	0.6 ± 0.2	1 ± 0.2	<0.001
Recurrent MR ≥ moderate		2 (2.8%)	8 (11.5%)	0.02

The Role of Papillary Muscle Relocation in Ischemic Mitral Valve Regurgitation.

Fattouch Khalil et al. **Semin Thoracic Surg 2012; 24:246-253**

CASE description



Fattouch et al, JTCVS, 2012

The NEW ENGLAND JOURNAL of MEDICINE
2014;370:23-32

ORIGINAL ARTICLE

Mitral-Valve Repair versus Replacement for Severe Ischemic Mitral Regurgitation

Michael A. Acker, M.D., Michael K. Parides, Ph.D., Louis P. Perrault, M.D., Alan J. Moskowitz, M.D., Annetine C. Gelijns, Ph.D., Pierre Voisine, M.D., Peter K. Smith, M.D., Judy W. Hung, M.D., Eugene H. Blackstone, M.D., John D. Puskas, M.D., Michael Argenziano, M.D., James S. Gammie, M.D., Michael Mack, M.D., Deborah D. Ascheim, M.D., Emilia Bagiella, Ph.D., Ellen G. Moquete, R.N., T. Bruce Ferguson, M.D., Keith A. Horvath, M.D., Nancy L. Geller, Ph.D., Marissa A. Miller, D.V.M., Y. Joseph Woo, M.D., David A. D'Alessandro, M.D., Gorav Ailawadi, M.D., Francois Dagenais, M.D., Timothy J. Gardner, M.D., Patrick T. O'Gara, M.D., Robert E. Michler, M.D., and Irving L. Kron, M.D., for the CTSN*

Results

At 12 months, the mean LVESVI among surviving patients was 54.6±25.0 ml per square meter of body-surface area in the repair group and 60.7±31.5 ml per square meter in the replacement group (mean change from baseline, −6.6 and −6.8 ml per square meter, respectively). The rate of death was 14.3% in the repair group and 17.6% in the replacement group (hazard ratio with repair, 0.79; 95% confidence interval, 0.42 to 1.47; P = 0.45 by the log-rank test). There was **no significant between-group difference in LVESVI** after adjustment for death (z score, 1.33; P = 0.18). The rate of moderate or severe recurrence of **mitral regurgitation at 12 months was higher in the repair group** than in the replacement group **(32.6% vs. 2.3%, P<0.001)**. There were **no significant between-group differences in the rate of a composite of major adverse** cardiac or cerebrovascular **events,** in **functional status,** or in **quality of life** at 12 months.

Mitral-Valve Repair versus Replacement for Severe Ischemic Mitral Regurgitation

Acker et al N Engl J Med 2014;370:23-32

…

In the repair group, the 12-month **LVESVI** was **64.1±23.9** ml per square meter in patients with **recurrent** mitral regurgitation versus **47.3±23.0** ml per square meter in those **without recurrent** mitral regurgitation (P<0.001).

…

PREDICTING RECURRENT MR FOLLOWING REPAIR FOR SEVERE IMR

I. L. Kron et al *J. Thorac Cardiovasc Surg in press*

Objective: … whether baseline echocardiographic and clinical characteristics could identify those who will develop moderate/severe recurrent mitral regurgitation or die.

Results: 110 pts (116-6): over 2 years

34 (31%)		perfect	
53	60%	MR rec	30% at 1m
13		MR rec + †	
10		†	

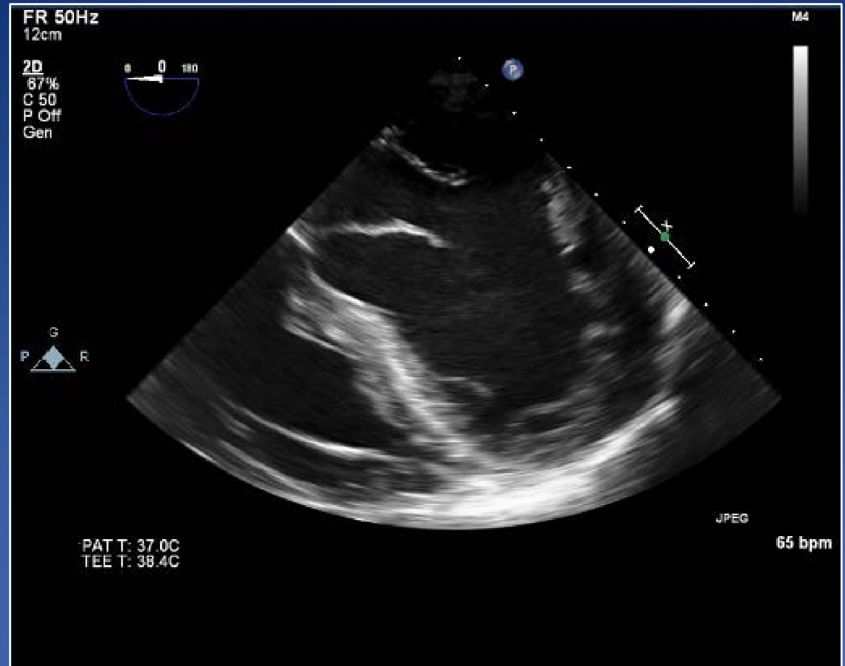
Conclusions: 10 variables model demonstrated good discrimination (AUC 0.82).

Baseline patient characteristics by patient outcomes

Characteristic	No Recurrence or Death (N=40)	Recurrence and/or Death (N=76)	P-value	No Recurrence (N=44)	Recurrence (N=66)	P-value
Age (y)	65.7 ± 12.5	70.6 ± 8.6	0.030	67.0 ± 12.6	69.6 ± 8.7	0.237
BMI (kg/m²)	28.1 ± 4.8	26.7 ± 4.3	0.106	27.9 ± 4.7	27.0 ± 4.4	0.300
Male	28 (70.0)	42 (55.3)	0.123	30 (68.2)	37 (56.1)	0.202
White	36 (90.0)	59 (77.6)	0.100	40 (90.9)	50 (75.8)	**0.044**
EROA (cm²)	0.4 ± 0.1	0.4 ± 0.2	0.219	0.4 ± 0.1	0.4 ± 0.2	0.128
Basal Dyskinesia/Aneurysm *	8 **(20.0)**	44 **(57.9)**	<0.001	9 **(20.5)**	41 **(62.1)**	<0.001
NYHA Class I+II	10 (25.0)	40 (52.6)	0.004	13 (29.5)	34 (51.5)	0.022
NYHA Class III+IV	30 **(75.0)**	36 **(47.4)**		31 **(70.5)**	32 **(48.5)**	
History of CABG	4 (10.0)	15 (19.7)	0.178	4 (9.1)	13 (19.7)	0.132
History of PCI	13 (32.5)	34 (44.7)	0.202	15 (34.1)	30 (45.5)	0.235
History of Ventricular Arrhythmia	8 **(20.0)**	6 **(7.9)**	0.074	10 **(22.7)**	3 **(4.5)**	0.004

* 50 pts

J. Thorac Cardiovasc Surg in press. Kron et al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2D
67%
C 50
P Off
Gen
0 180
M4
G
P R
JPEG
PAT T: 37.0C
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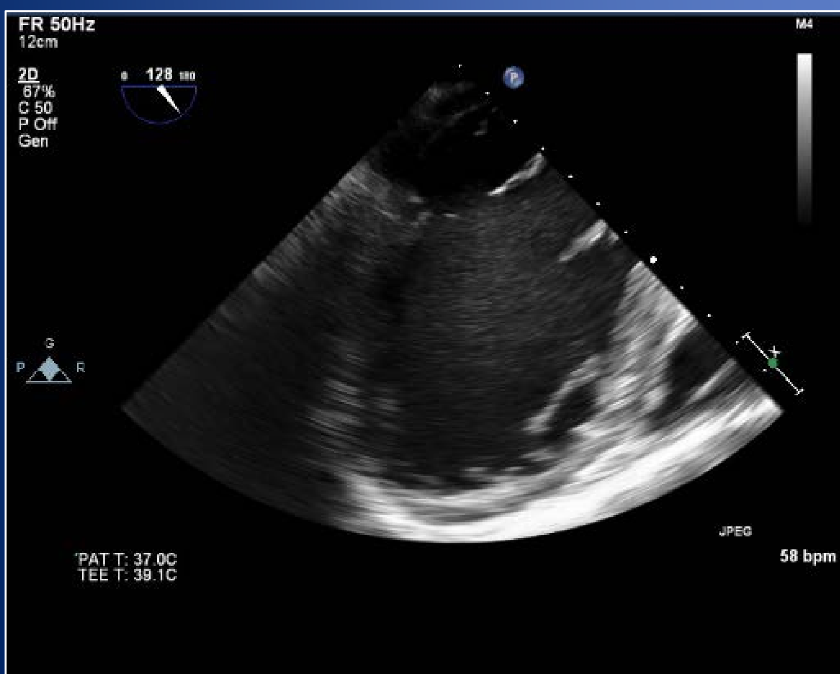
65 bpm

preop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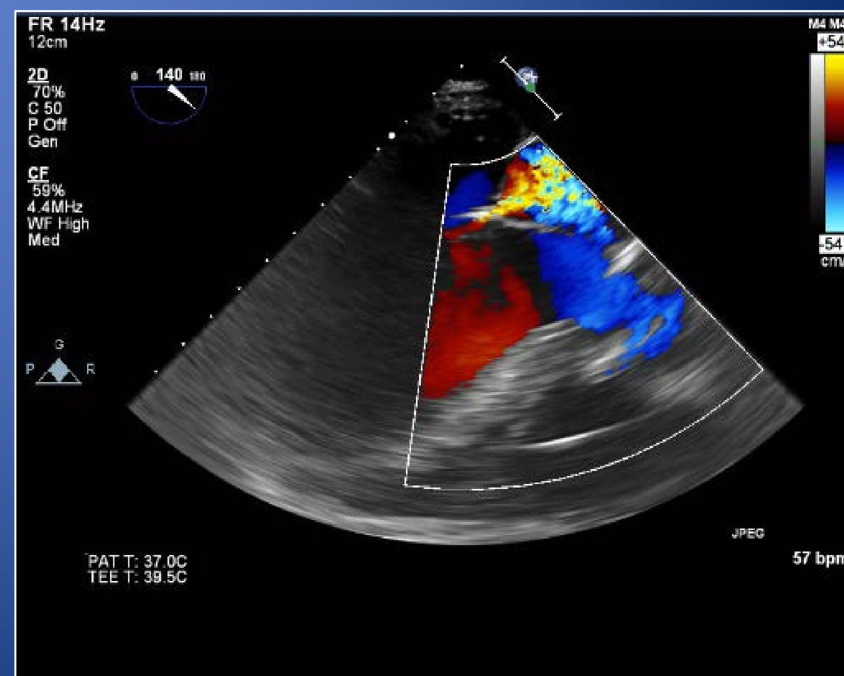
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2D
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CF
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WF High
Med
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-54.2
cm/s
G
P R
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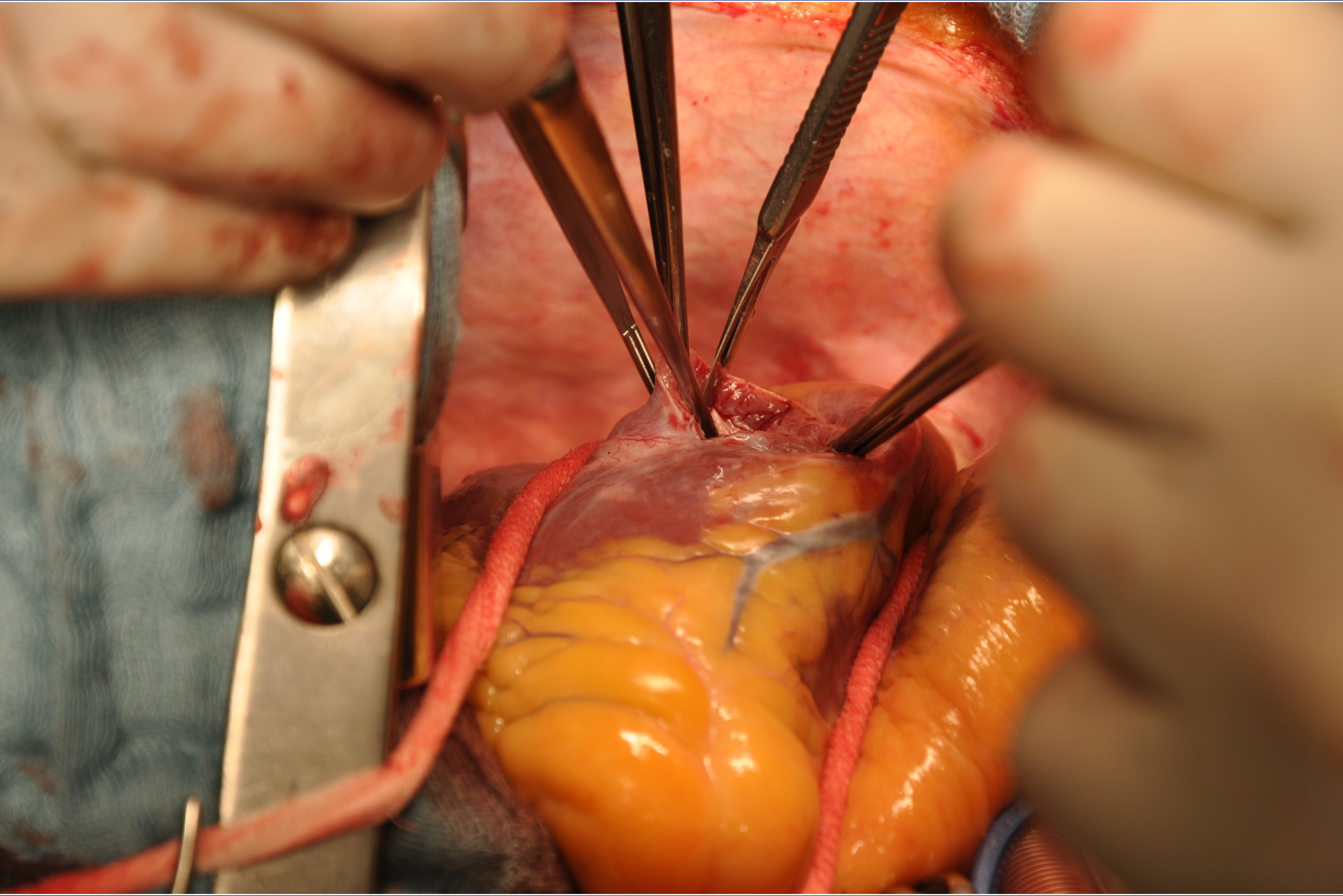
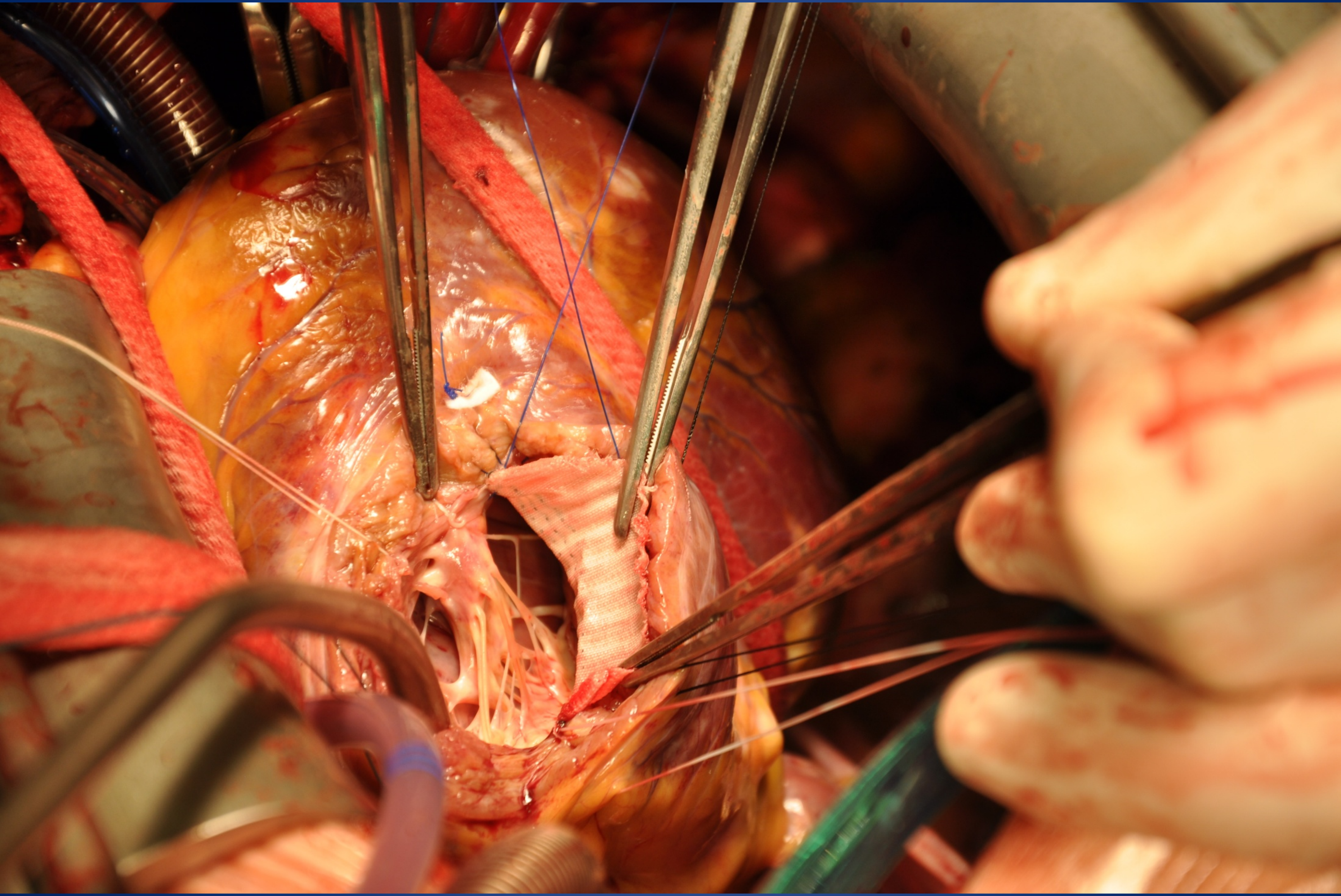
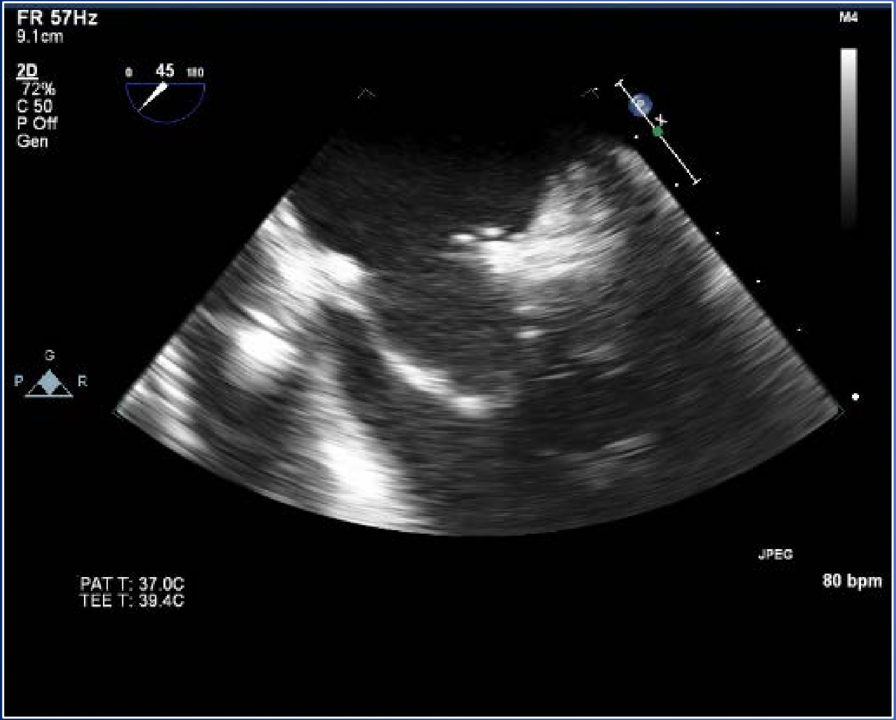
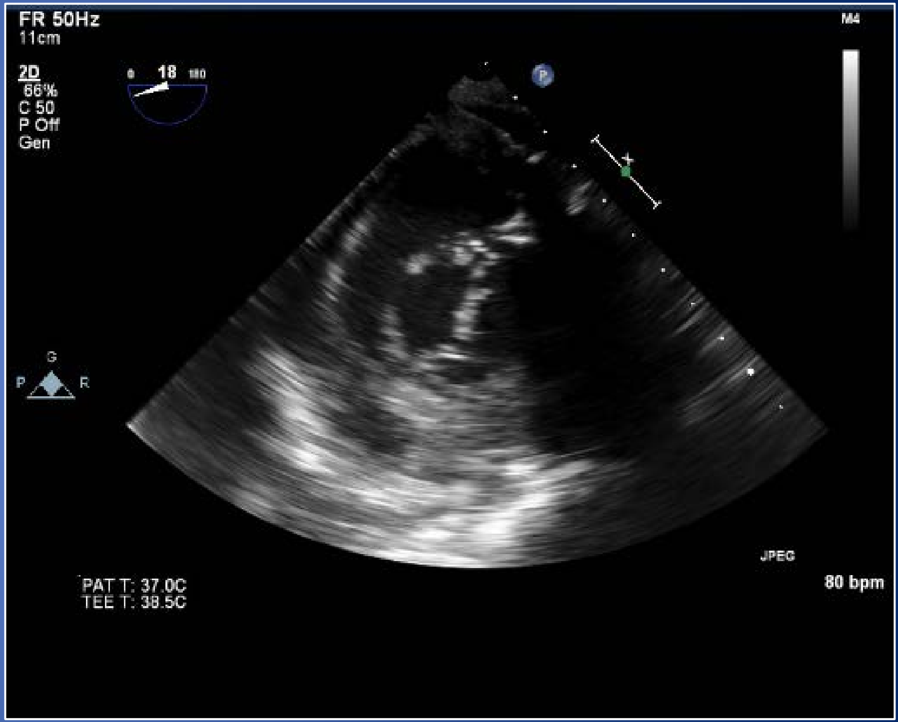
TEE T: 39.5C
57 bpm







postop



postop

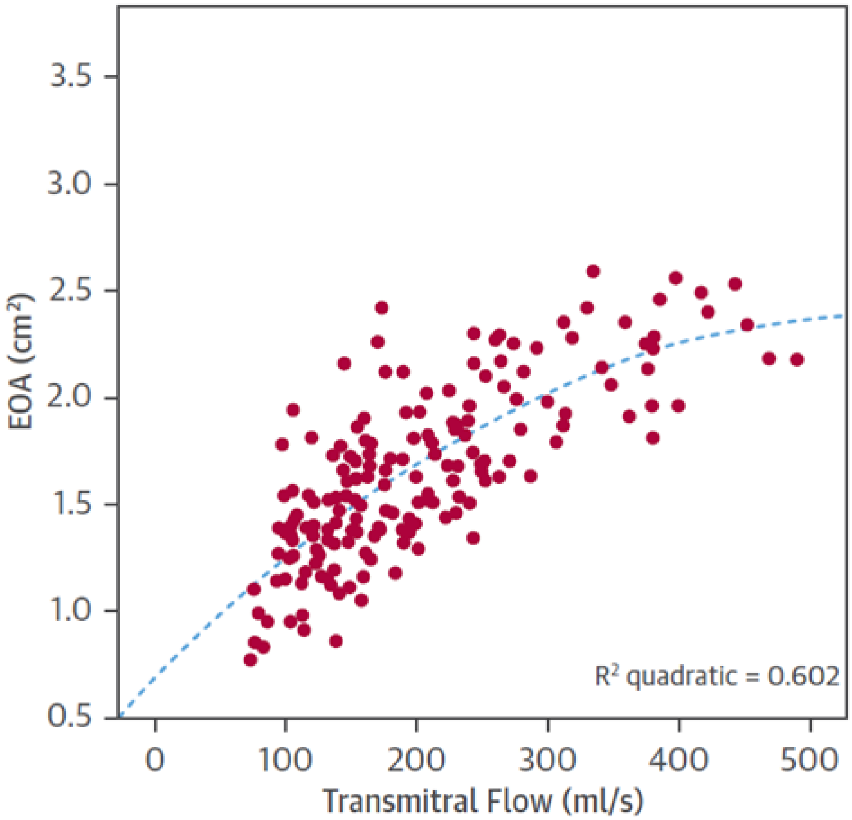
MVR in IMR ?

- Mechanical or bioprosthesis ?

- Which size ?

- What if reverse remodeling and bioprosthesis ?

Results



Exercise-induced increase in effective mitral valve area...

...despite fixed rigid ring annuloplasty.

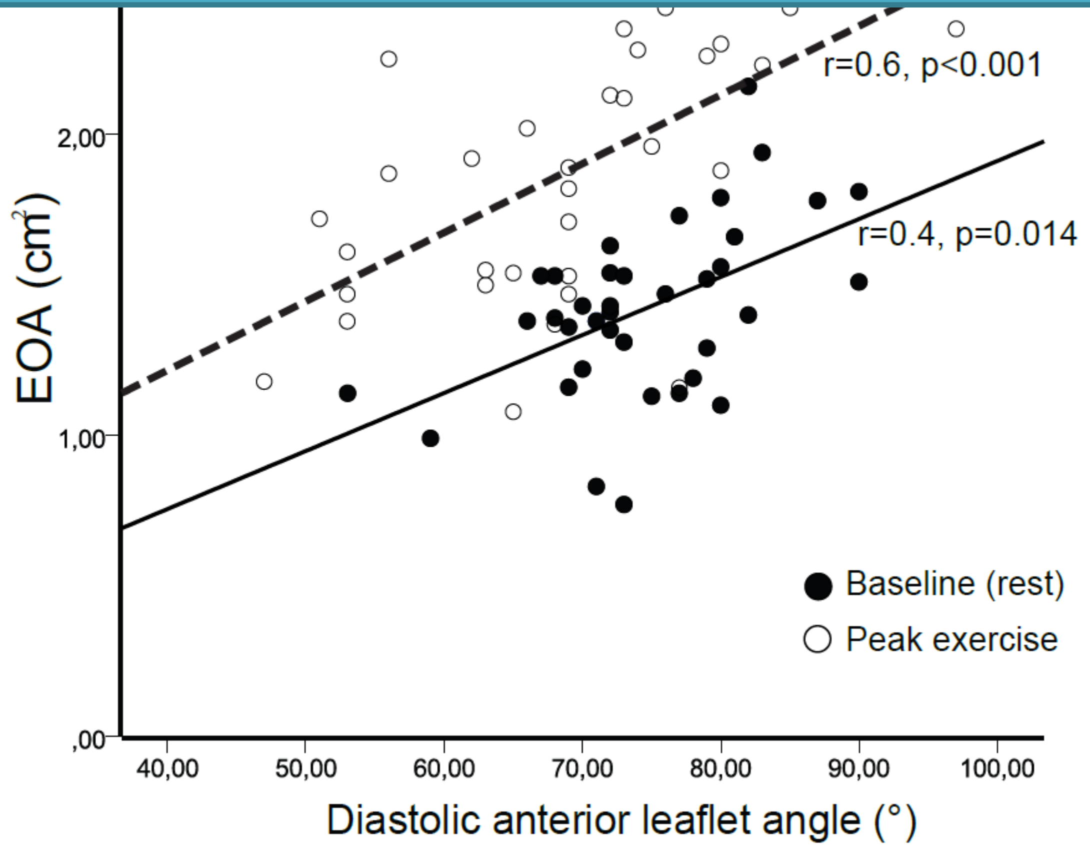
→ functional stenosis at level of the leaflets rather than at level of ring?

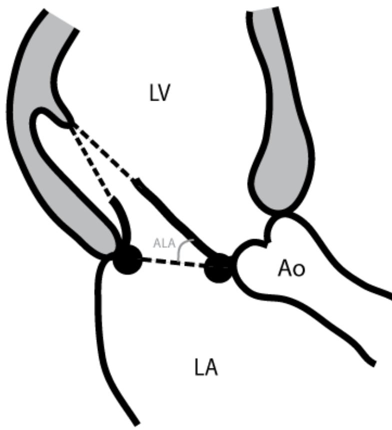
Bertrand PB, Dion RA et al, J Am Coll Cardiol 2015;65:452-61

Results

1. EOA at peak exercise correlates well with anterior leaflet opening angle..

2. Higher increases in anterior leaflet angle results in higher increases in EOA during exercise.





Bertrand PB, Dion RA et al, J Am Coll Cardiol 2015;65:452-61

Addendum

- Comparison with mechanical mitral valve replacement (MVR):
  - 16 MVR patients versus propensity-matched restrictive annuloplasty subgroup (n=16)

CONCLUSION:

In contrast to restrictive mitral annuloplasty, the effective mitral valve area following mechanical MVR does not increase during exercise.

Therefore, important hemodynamic difference exist during exercise, in favour of valve repair (if durable result is obtained)

Bertrand PB, Dion RA et al, ACC.14, Washington

Conclusions

- In RMA patients, effective mitral valve area increases during exercise, despite fixed annular size.

- Diastolic AL tethering plays a key role in this dynamic process, with increasing AL opening during exercise being associated with higher exercise mitral valve area.

- Indexed effective valve area at peak exercise is a strong and independent predictor of exercise capacity and is associated with clinical outcome.

→ **These findings stress the importance of maximizing AL opening by targeting the subvalvular apparatus in future repair algorithms.**

Bertrand PB, Dion RA et al, J Am Coll Cardiol 2015;65:452-61

CONCLUSIONS

1) Always consider repair BUT

NO RESIDUAL MR ! MVR ?

2) LVEDD 65 ≤ LVESD 51 : RMA ± LV procedure

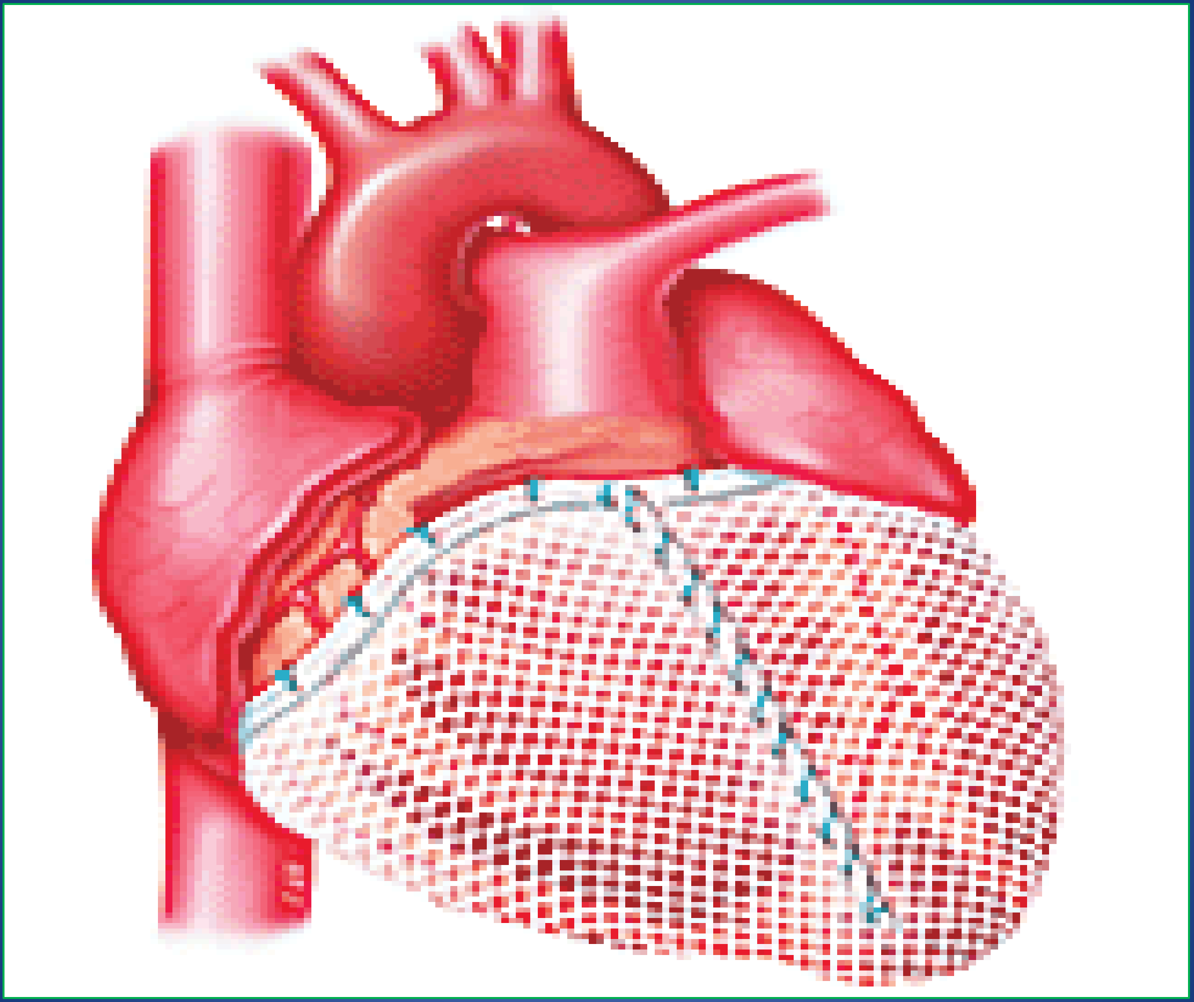
3) LVEDD 65 > LVESD 51 : INVENTIVITY OR MVR ?

- Leaflet augmentation
- Constraint device (?)
- PM procedures

BUT

? ? Efficacy in truly dilated LV

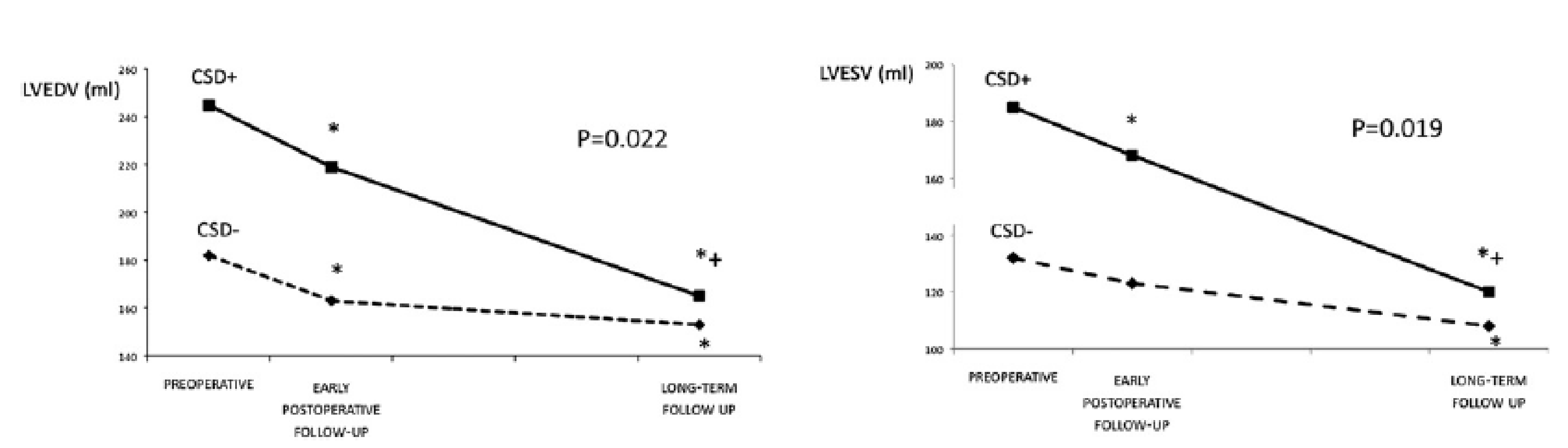
CorCap™



Braun J. et al. J Thorac Cardiovasc Surg 2011;142:e93-e100

CSD + RMA + OMT

Evolution of LVEDV and LVESV at early postoperative follow-up, and at long-term follow-up



Braun et al, *J Thorac Cardiovasc Surg* 2011;142:e93-e100

Impact of Mitral Valve Annuloplasty Combined With Revascularization in Patients With Functional Ischemic Mitral Regurgitation

Tomislav Mihaljevic, MD,* Buu-Khanh Lam, MD,* Jeevanantham Rajeswaran, MSc,†
Masami Takagaki, MD,* Michael S. Lauer, MD,‡ A. Marc Gillinov, MD,*
Eugene H. Blackstone, MD,*† Bruce W. Lytle, MD*

Cleveland, Ohio

Objectives The aim of this work was to determine whether mitral valve (MV) annuloplasty benefits patients with moderate/severe (3+/4+) functional ischemic mitral regurgitation (MR) who undergo coronary artery bypass grafting (CABG).

Background Mitral regurgitation is a strong predictor of poor outcomes in patients with ischemic cardiomyopathy; whether correcting it at the time of CABG improves outcomes is less certain.

Methods From 1991 to 2003, 390 patients with 3+/4+ ischemic MR had CABG with ($n = 290$) or without ($n = 100$) MV annuloplasty. Groups were propensity-matched using demographics, extent of coronary disease, regional wall motion, and quantitative electrocardiography. Survival, echocardiographic severity of MR, and New York Heart Association (NYHA) functional class were compared.

Results One-, 5-, and 10-year survival was 88%, 75%, and 47% after CABG alone and 92%, 74%, and 39% after CABG + MV annuloplasty ($p = 0.6$). Mortality was increased in patients with severe lateral wall motion abnormalities ($p = 0.05$), ST-segment elevation in lateral leads ($p < 0.004$), and higher QRS voltage sum ($p < 0.0001$). Patients undergoing CABG alone were more likely to have 3+/4+ postoperative MR than those undergoing CABG + MV annuloplasty (48% vs. 12% at 1 year, $p < 0.0001$). The NYHA functional class substantially improved in both groups ($p < 0.001$) and remained improved; at 5 years, 23% of patients having CABG + mitral annuloplasty and 25% having CABG alone were in NYHA functional class III/IV.

Conclusions Although CABG + MV annuloplasty reduces postoperative MR and improves early symptoms compared with CABG alone, it does not improve long-term functional status or survival in patients with severe functional ischemic MR. The MV annuloplasty in this setting, without addressing fundamental ventricular pathology, is insufficient to improve long-term clinical outcomes. (J Am Coll Cardiol 2007;49:2191–201)

Recurrent mitral regurgitation after annuloplasty for functional ischemic mitral regurgitation

Edwin C. McGee, Jr, MD[a]
A. Marc Gillinov, MD[a]
Eugene H. Blackstone, MD[a,b]
Jeevanantham Rajeswaran, MSc[b]
Gideon Cohen, MD[a]
Farzad Najam, MD[a]
Takahiro Shiota, MD[c]
Joseph F. Sabik, MD[a]
Bruce W. Lytle, MD[a]
Patrick M. McCarthy, MD[a]
Delos M. Cosgrove, MD[a]

Results: During the first 6 months after repair, the proportion of patients with 0 or 1+ mitral regurgitation decreased from 71% to 41%, whereas the proportion with 3+ or 4+ regurgitation increased from 13% to 28% ($P < .0001$); the regurgitation grade was stable thereafter. The temporal pattern of development of 3+ or 4+ regurgitation was similar for Cosgrove bands and Carpentier rings (25%) but substantially worse for Peri-Guard annuloplasties (66%). Small annuloplasty size did not influence postoperative regurgitation grade ($P = .2$), although Cosgrove bands were used in most patients receiving 26- and 28-mm annuloplasties. Freedom from reoperation was 97% at 5 years. Annuloplasty type was not associated with survival.

Recurrent mitral regurgitation after annuloplasty for functional ischemic mitral regurgitation

Edwin C. McGee et al. J Thorac Cardiovasc Surg 2004;128:916-24

Patients and Methods

Concomitant procedures included coronary artery bypass grafting (585 [95%] patients) and tricuspid valve repair (62 [11%] patients). Patients who underwent a concomitant aortic valve procedure or left ventricular restoration were excluded.

Annuloplasty types included the Carpentier-Edwards Classic annuloplasty ring (n = 122 [21%]; Carpentier ring; Edwards Lifesciences, Irvine, Calif), the Cosgrove-Edwards annuloplasty system (n = 396 [68%]; Cosgrove band; Edwards Lifesciences), and bovine pericardial annuloplasty (n = 67 [11%]; Peri-Guard; Bio-Vascular, Saint Paul, Minn). Early in the series, Carpentier rings were used most commonly, and downsizing was inconsistent. Since 1997, most patients have received Cosgrove bands, with a practice of implanting 26-mm bands in women and 28-mm bands in men (see Electronic Appendixes 1 and 2 available at www.mosby.com/jtcvs). Median annuloplasty size was 28 mm for Cosgrove bands and 30 mm for Carpentier rings.

IMR : VALVULAR PROCEDURES

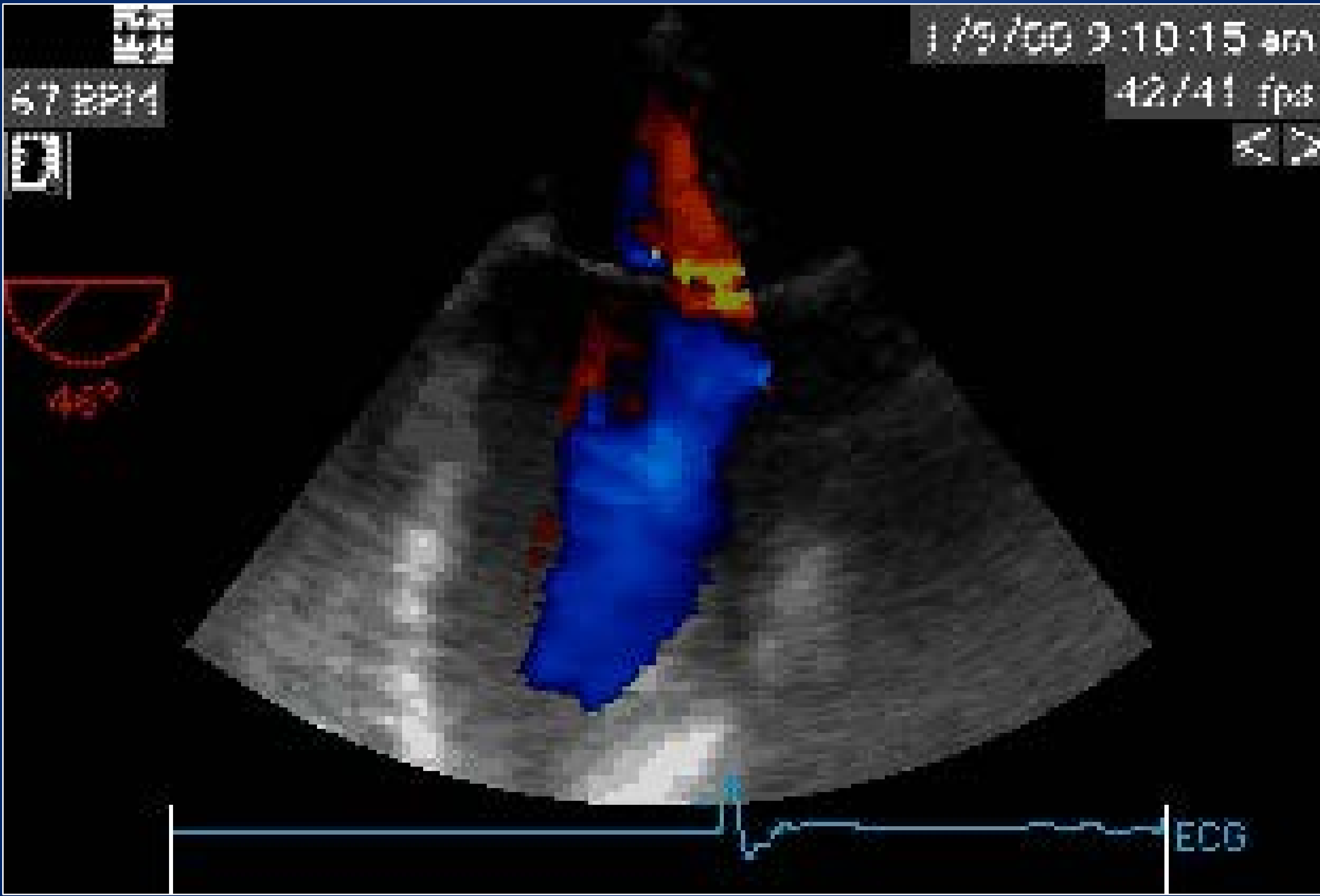
PREOPERATIVE DYNAMIC TESTING

INTERMITTENT
FLUCTUATING | **MR**
GRADE II

Aorta cannulated, Swan–Ganz

TEE

Loading test :	PCWP + 15 mmHg
Afterload test :	Ephedrin 5 mg bolus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42/41 fps
ECG


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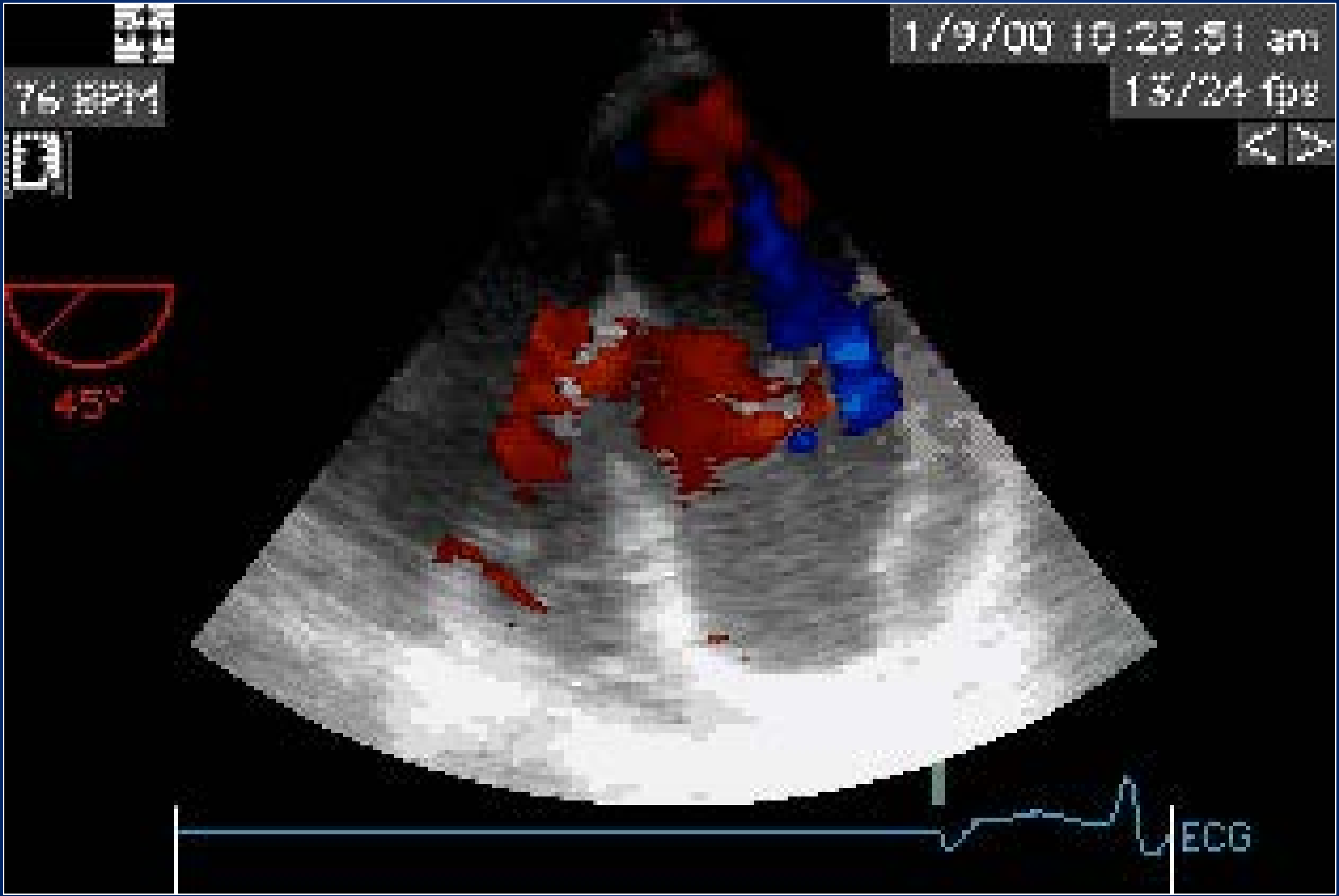
ECG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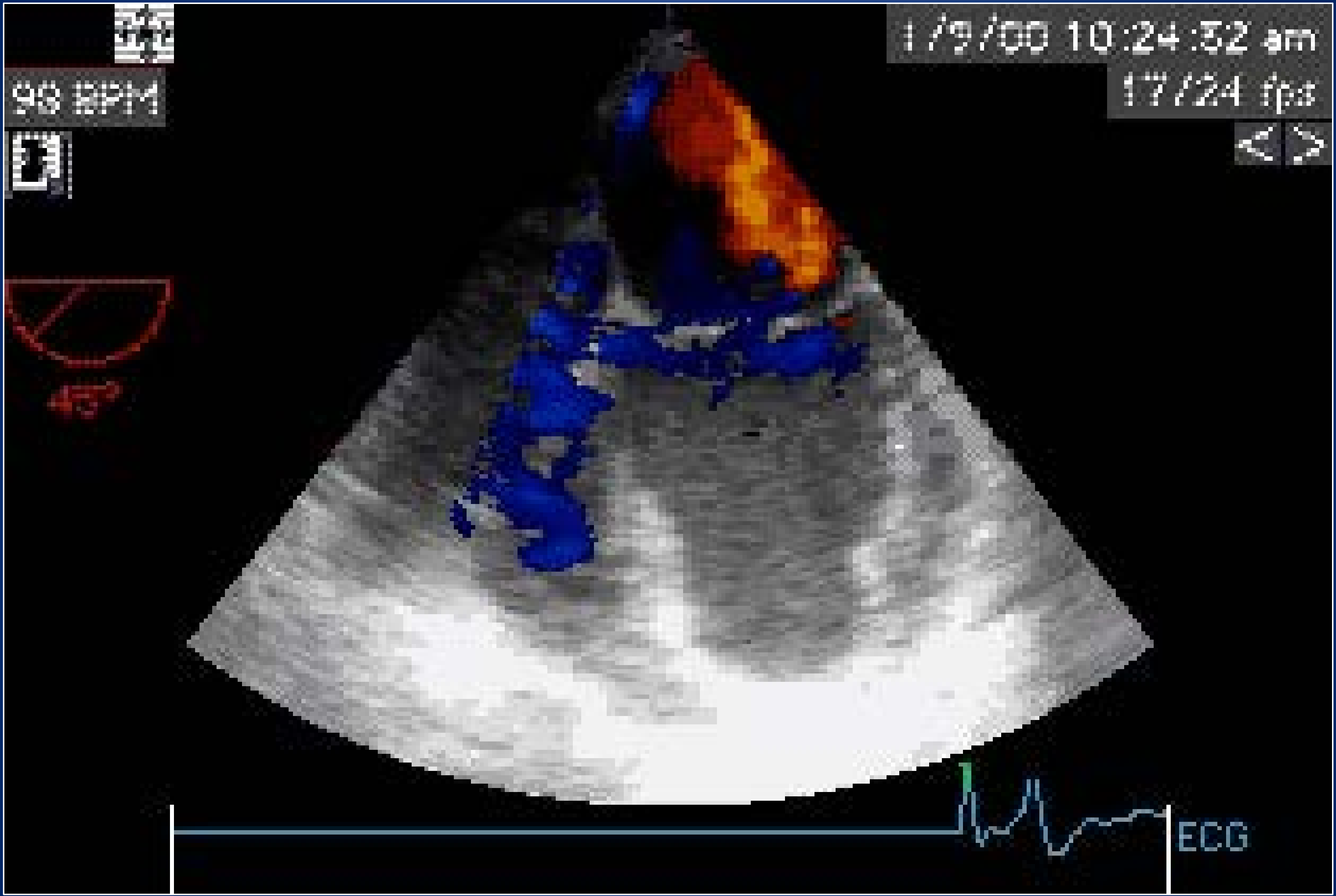
45°
ECG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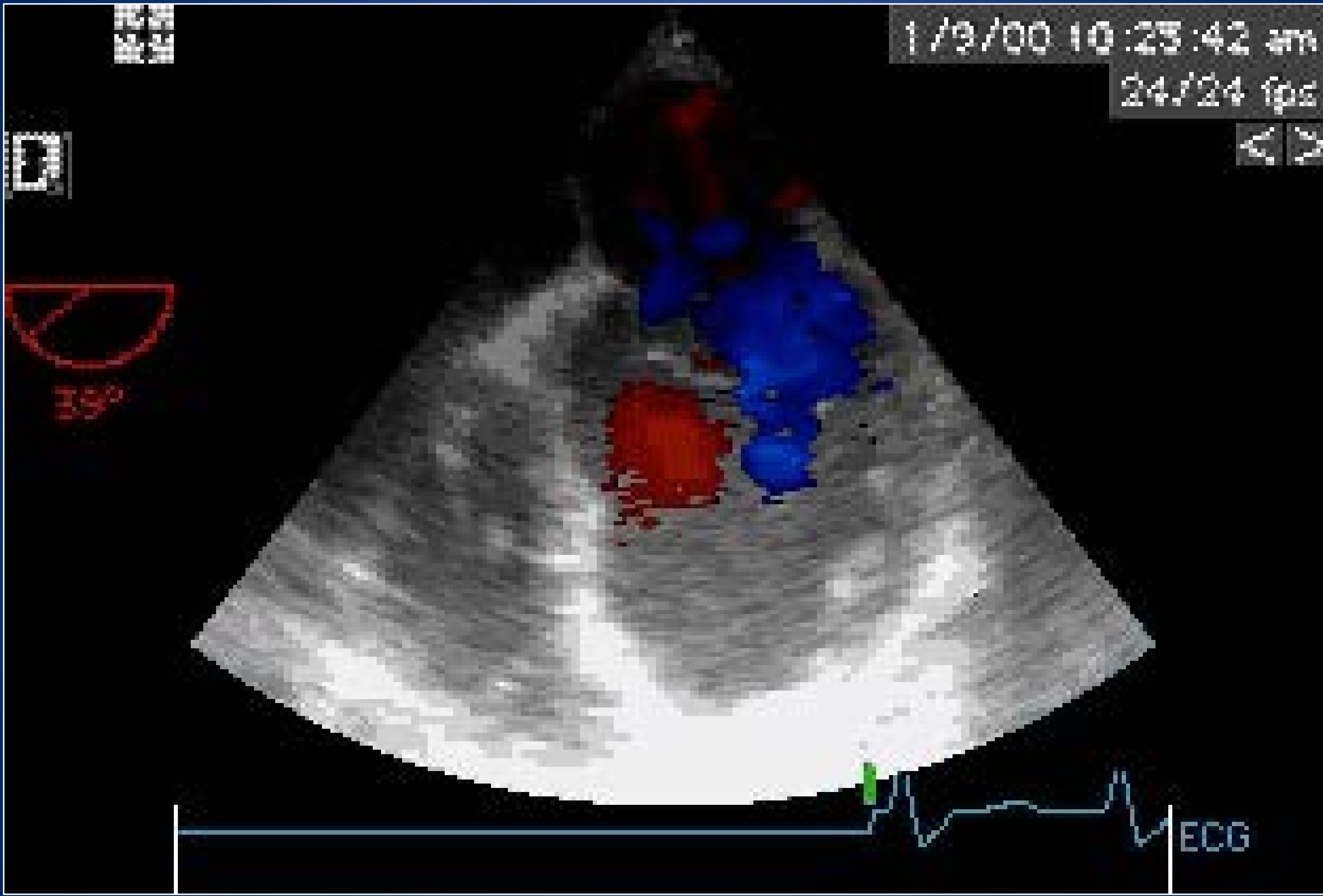
ECG



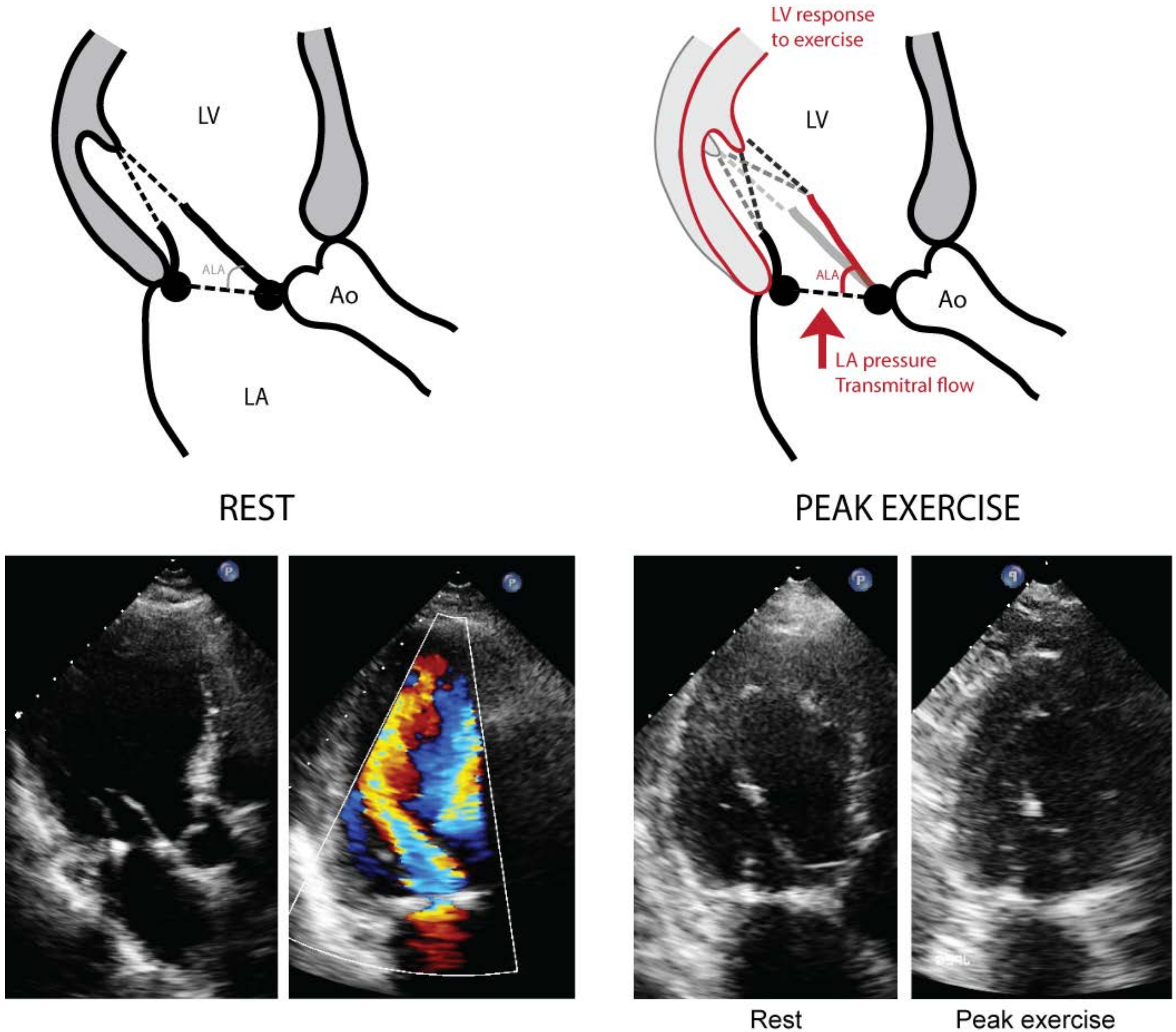
1/9/00 10:23:42 am
24/24 fps
ECG

Baseline patient characteristics by patient outcomes

Age (y)	Tenting Height (cm)
BMI (kg/m^2)	Basal Aneurysm
Male	NYHA Class I+II
White	NYHA Class III+IV
EDV (ml)	Planned Revascularization
EF (%)	History of AF
EROA (cm^2)	History of CABG
ESV (ml)	Chronic Lung Disease (≥Moderate)
LVEDD Mid-Ventricle (cm)	Diabetes
LVESD Mid-Ventricle (cm)	History of Heart Failure
MR Peak Velocity (cm/sec)	Hypertension
Vena Contracta (cm)	History of MI
Angle (anterior-ap4) (°)	History of PCI
Angle (posterior-ap4) (°)	History of Renal Insufficiency
Sphericity index (ED)	Previous Valve Repair
Sphericity index (ES)	Previous Valve Replacement
Tenting Area (cm^2)	History of Ventricular Arrhythmia

J. Thorac Cardiovasc Surg in press. Kron et al

Results

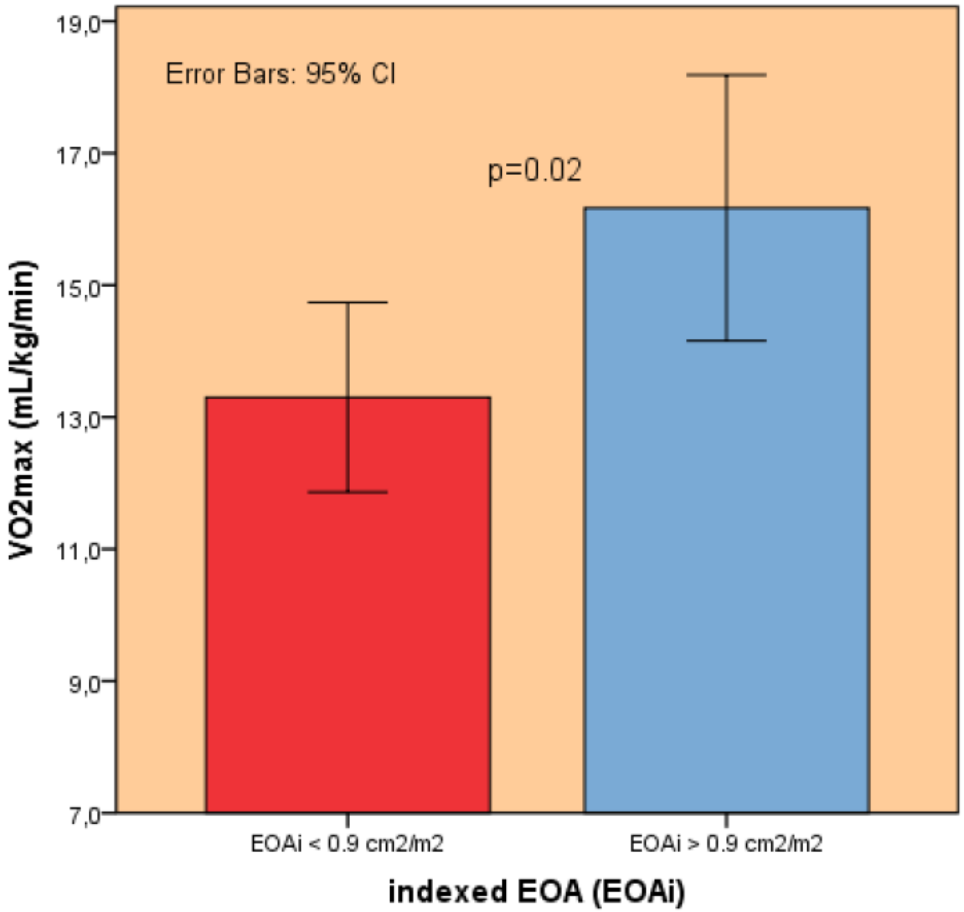


Bertrand PB, Dion RA et al, J Am Coll Cardiol 2015;65:452-61

Results

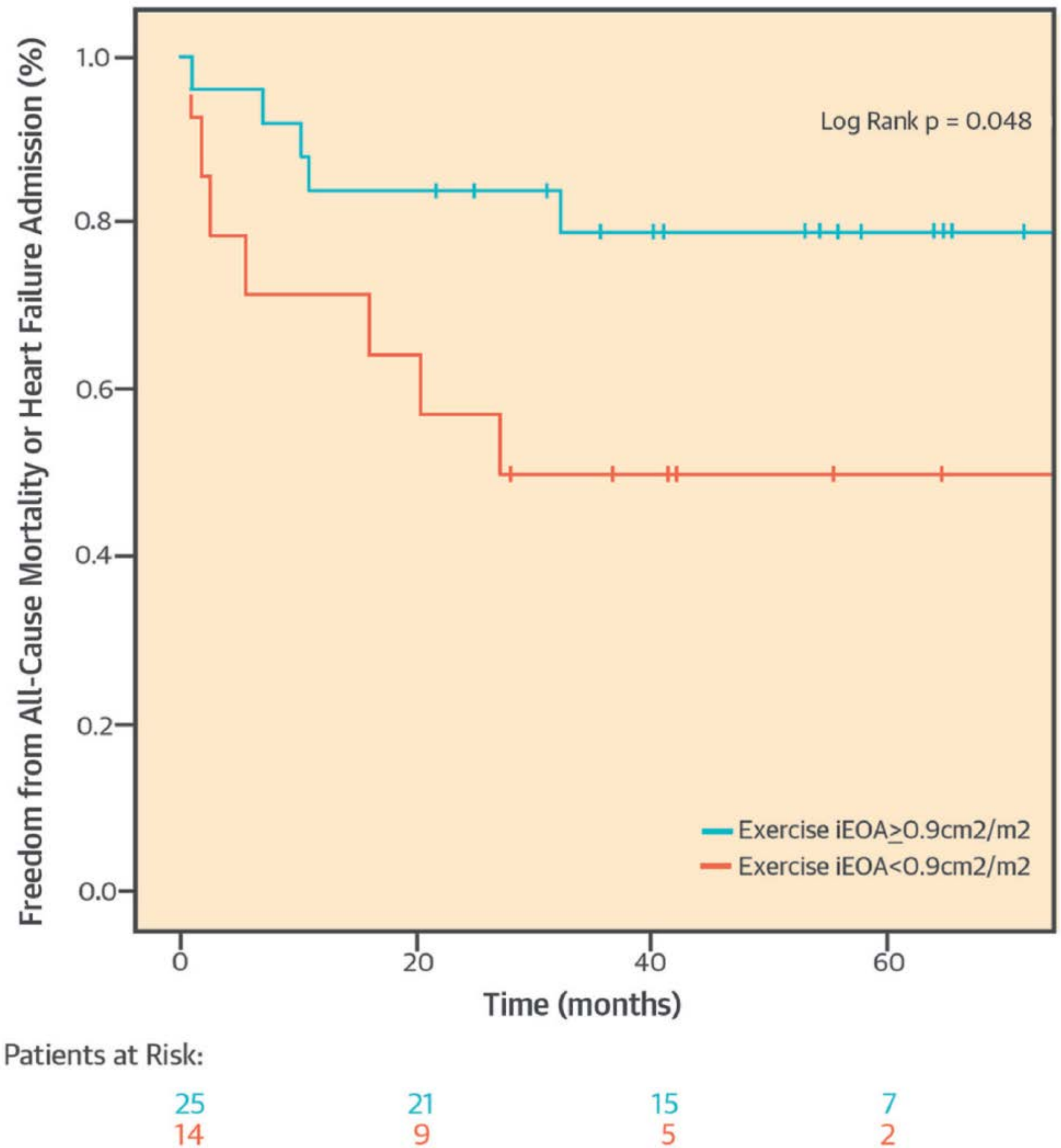
Exercise capacity (VO_2max)

EOA at peak exercise < **0.9cm²/m²** versus ≥ **0.9cm²/m²**



Bertrand PB, Dion RA et al, J Am Coll Cardiol 2015;65:452-61

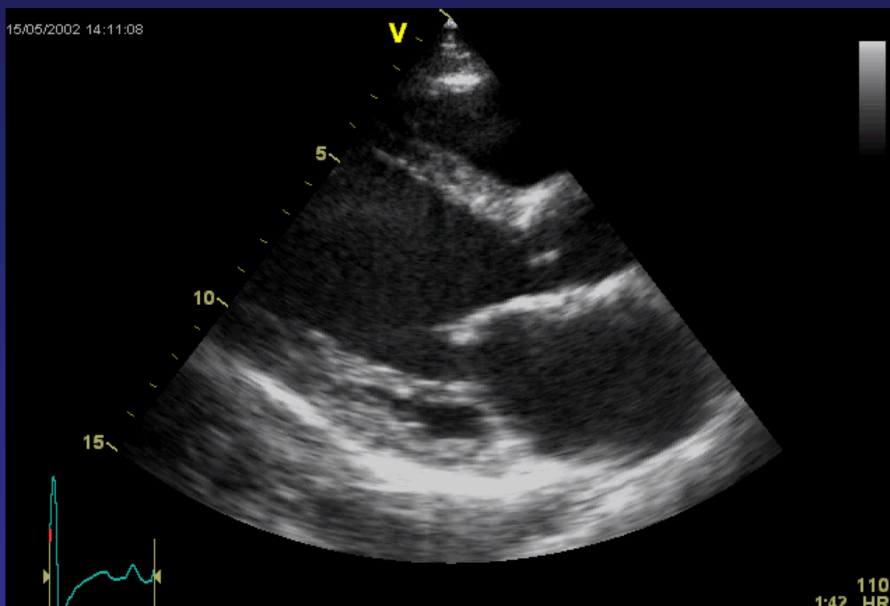
Results



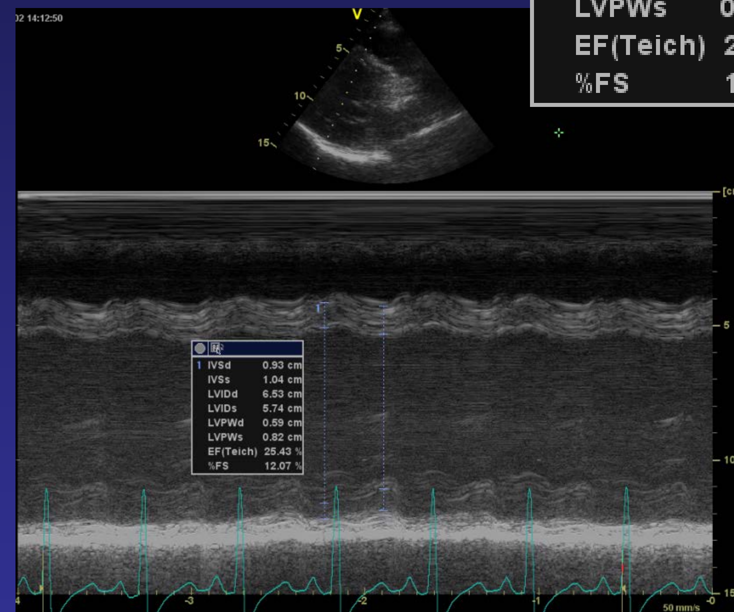
Bertrand PB, Dion RA et al, J Am Coll Cardiol 2015;65:452-61

preoperative images

1	IVSd	0.93 cm
	IVSs	1.04 cm
	LVIDd	6.53 cm
	LVIDs	5.74 cm
	LVPWd	0.59 cm
	LVPWs	0.82 cm
	EF(Teich)	25.43 %
	%FS	12.07 %

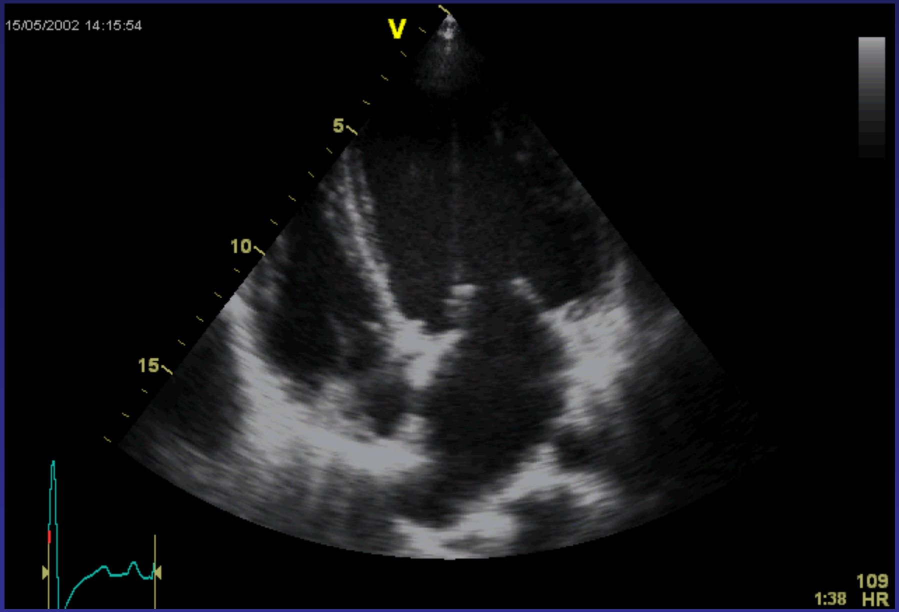


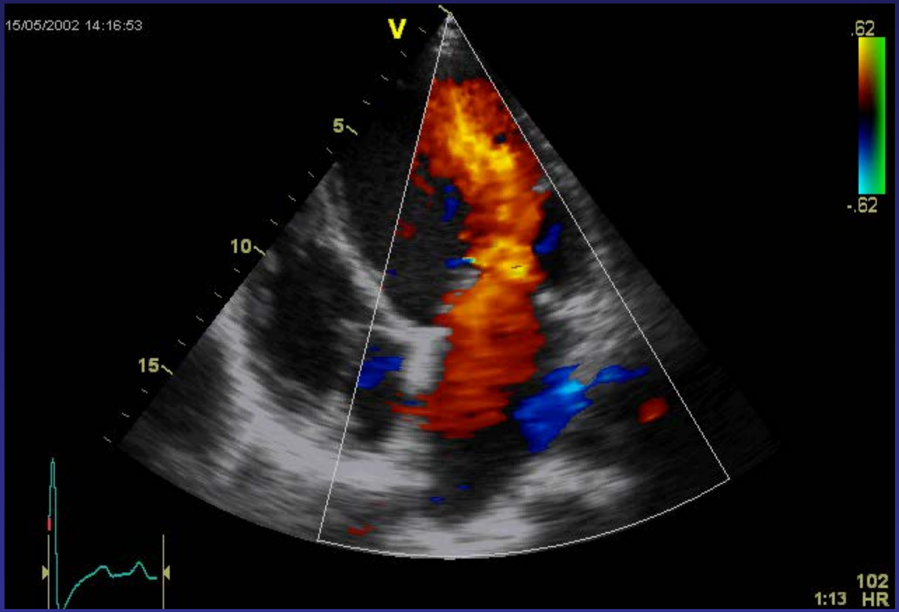
Parasternal long axis.
Moderate LV function.
Restrictive MV motion.



MMode: LV diameter end-diastolic: 6,5 cm.

preoperative images



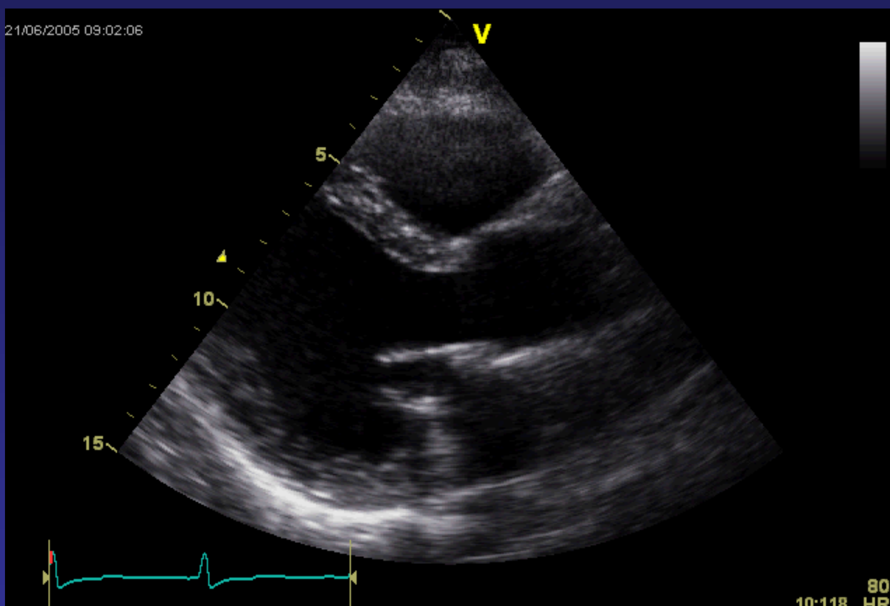


Apical two chamber view.
Note the restrictive closure of the mitral valve.

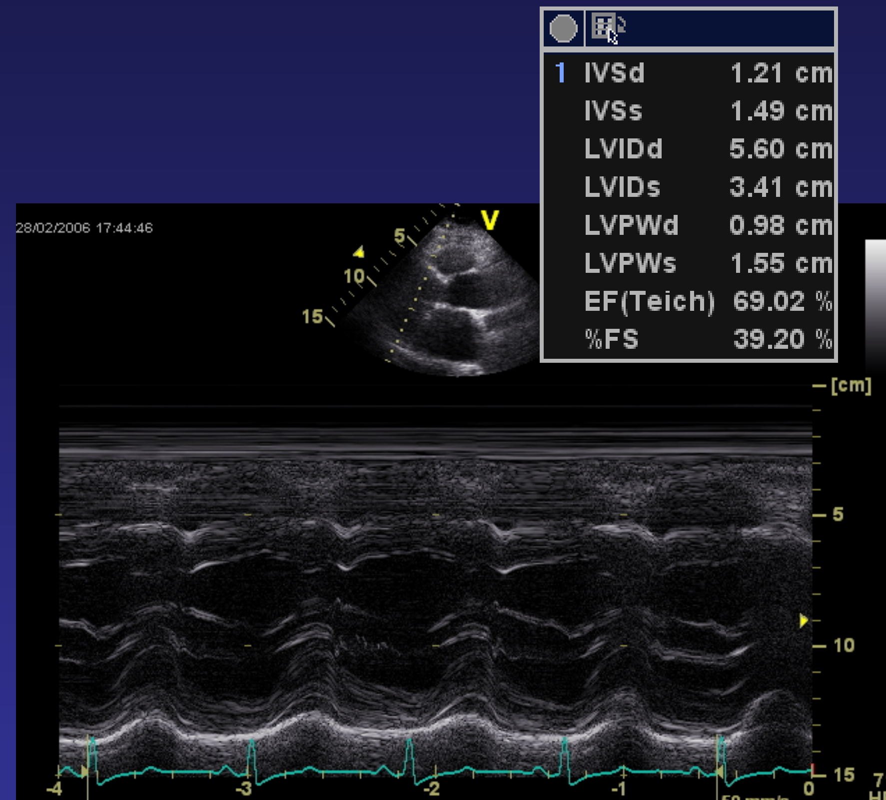
Apical four chamber view, color-Doppler encoded.

Note the severe regurgitation.

postoperative images



Parasternal short axis 3 years after repair.
Note the improved systolic function.



MMode: LV diameter end-diastolic: 4,6 cm.
LVIDd showed 1,9 cm regression to normal value.

Results

Exercise Doppler measurements	Resting	Peak exercise	p-value
MV peak gradient, mmHg	11.4 ± 3.6	16.8 ± 6.1	<0.001
MV mean gradient, mmHg	4.4 ± 1.8	8.2 ± 4.2	<0.001
Systolic PAP, mmHg	43 ± 13	53 ± 20	0.012
Cardiac output, L/min	3.9 ± 0,8	5.8 ± 2.0	<0.001
MR vena contracta width, mm	1.3 ± 1.0	1.3 ± 1.2	NS

<5mmHg (n=14)

≥ 5mmHg (n=9)

Bertrand PB, Dion RA et al, J Thorac Cardiovasc Surg 2014;148:183-7

Results

Exercise Doppler measurements	Mean gradient <5mmHg (n=14)		Mean gradient >5mmHg (n=9)		p-value	
Variable	Resting	Exercise	Resting	Exercise	Resting	Exercise
MV peak gradient, mmHg	9.5 ± 2.7	13.1 ± 4.3	14.5 ± 2.6	22.6 ± 3.4	<0.001	<0.001
MV mean gradient, mmHg	3.3 ± 1	5.7 ± 1.6	6.2 ± 1	12.0 ± 4.0	<0.001	<0.001
Syst. PAP, mmHg	43 ± 15	46 ± 26	43 ± 11	50 ± 20	0.94	0.71
Cardiac output	3.6 ± 0.8	4.7 ± 1.3	4.4 ± 0.8	7.3 ± 2.0	0.03	0.001
MR VC width, mm	1.2 ± 1.2	1.2 ± 1.2	1.4 ± 0.7	1.3 ± 1.3	NS	NS

Comparison of other variables:			
LV EF,%	42 ± 16	53 ± 7	0.036
LV EDV, ml	138 ± 55	105 ± 30	0.076
LV ESV, ml	86 ± 49	50 ± 15	0.020
Maximal workload, Watt	38 ± 14	69 ± 23	<0.001
VO_2max, ml/kg/min	12.3 ± 3.4	15.3 ± 2.6	0.035

Bertrand PB, Dion RA et al, J Thorac Cardiovasc Surg 2014;148:183-7

Conclusions

- Transmitral gradients following RMA are not merely determined by the degree of functional stenosis, but also depend of flow (cardiac output).

- Functional capacity (VO_2max) following RMA is not necessarily worse in patients with a higher transmitral gradient.

→ a **flow-independent measure** should be validated for comparison of postoperative results in this population.

Effective mitral valve area?

Bertrand PB, Dion RA et al, J Thorac Cardiovasc Surg 2014;148:183-7